DECOMMISSIONING NUCLEAR POWER PLANTS: THE SHIPPINGPORT PROJECT

HEARING

BEFORE THE

SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

AND THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

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DECOMMISSIONING NUCLEAR POWER PLANTS: THE SHIPPINGPORT PROJECT

WEDNESDAY, JULY 30, 1986

House of Representatives, Committee on Science and Technology, Subcommittee on Investigations and Oversight, and the Subcommittee on Energy Research and Production,

Washington, DC.

The subcommittee met, pursuant to notice, at 9:34 a.m., in room 2325, Rayburn Office Building, Hon. Marilyn Lloyd (chairman of the Subcommittee on Energy Research and Production) presiding.

Mrs. Lloyd. The subcommittees will come to order. Before we begin our hearings, I do ask unanimous consent that the committee permit today's proceedings to be recorded and be covered by the media and other persons, and without objection, so ordered.

Good morning. It has been some time since the Subcommittee on Energy Research and Production has reviewed the status of the decommissioning activities presently underway at the Shippingport Nuclear Power Station in Shippingport, PA. I am therefore pleased to join with my colleague, Representative Volkmer, in chairing this hearing which will bring us up to date on the progress that has been made by the Department of Energy and its contractors.

Certainly, this is indeed a one of a kind activity at the present time. The Shippingport Nuclear Power Station was the first commercial demonstration reactor in this country. It is also the largest such powerplant to undergo full decommissioning. Thus, it offers us a unique opportunity to gain insight into the procedures and processes that are required to safely remove, package, transport, and dispose of the radioactive components that comprise a nuclear power station. We are here today to learn from this experience in terms of the efforts that the Department is undertaking to carefully document and manage the various tasks. In this way, the Shippingport decommissioning activity can serve to aid utilities who may have to deal with decommissioning their own nuclear power plants in the not too distant future.

Two years ago, my Subcommittee on Energy Research and Production requested the Department to undertake technology transfer activities in conjunction with the remedial action program related to the decommissioning of the Shippingport reactor. Our intent was to transfer all appropriate new technology and information derived from the Shippingport activity to these utilities.

It is my hope that today the Department will provide us with an update on the status of this technology transfer activity. Although

Shippingport was indeed a prototype of a commercial powerplant, there are many features of the decommissioning activities that will significantly differ from that of larger powerplants. Nevertheless, we will be looking today at those areas where similarities can be identified between this program and what utilities may have to deal with in the future.

We are going to be looking at several aspects of the program, and in addition we will be investigating NRC's rulemaking activities as they relate to financing future decommissioning of nuclear power plants. It should also be noted that it is not clear what actions the utilities may be taking in the future. These activities may range all the way from simply shutting down a plant and maintaining it in a safe state, all the way through full-scale disassembly of a plant.

The future in this area is uncertain, and many utilities are looking at means for extending powerplant life in order to delay decisions relating to nuclear power plant shutdown and termination of operations, and I am sure that our deliberations today will review these aspects as well.

Again, I am pleased to participate in this joint hearing and trust that the information that we will derive today from the testimony received today will help us in determining the future course of decommissioning actions. This will help us to identify future oversight activities related to the decommissioning of nuclear power plants. Thus, the lessons to be learned at Shippingport are of interest to all of us.

At this time, I would certainly like to recognize my esteemed colleague from Missouri, the Honorable Harold Volkmer.

Mr. VOLKMER. I thank the gentlelady. I wish to join with her in welcoming all the witnesses today and am pleased to meet with the Subcommittee on Energy Research and Production on the question of decommissioning not only Shippingport, but also looking to the future as to the methodologies to be used as to the means of obtaining the cost for decommissioning and looking also as to whether or not we are going to be able to even have permanent sites for waste disposal in the future, and I think it is part of our job as the oversight function as to the NRC and regulations and also the efforts of the Department of Energy.

I wish to state that I recognize that DOE is basically—and I want to commend them—on top of the matter, and it is working very well, in recognizing the future problems, and also I think the nuclear industry, likewise—even though there may be some disagreements basically within the industry as to costing and decommissioning and methodology and doing so, and I think really what I am basically—and not only just Shippingport and what it is going to teach us, and I am sure it will teach us quite a bit as far as technology is concerned, but also looking to the future as to where we are going to be 15 years from now when we get some powerplants with 1,000-megawatt capacities ready to be decommissioned, and that timeframe, from that timeframe on, where are we going to be?

I don't think it is too early to be looking at those problems. I know that many in the nuclear industry have already done so. I am sure that the Nuclear Regulatory Commission and DOE have also, and so I wish to commend the lady from Tennessee for joining with us on this hearings, and I welcome the witnesses here today.

Mrs. Lloyd. Thank you very much, Mr. Volkmer. The Chair now recognizes the distinguished gentleman from California, Mr. Ron Packard.

Mr. Packard. Thank you, Madam Chairman. We in the Congress are often accused of crisis management, and more often than we'd like, we are guilty of that. That is why I am particularly interested, and happy, to join with the subcommittees in holding this hearing, to look ahead before we have a crisis. Our evaluation of the Federal Government's decommissioning activities at Shippingport, and other nuclear decommissioning projects, should provide information which commercial utilities can use to safely decommission their nuclear power plants in the future.

I am particularly pleased to welcome, and to have as a witness today, Dr. Larry Papay from the Southern California Edison Co., which services much of my district, and Mr. Terry Nelson from the Pacific Gas & Electric Co. Dr. Papay will provide a general industry point of view of what types of information commercial utilities need to accurately plan and implement decommissioning of their nuclear plants.

Further, he will give us a utility's view of the financial and regulatory issues, which are an integral part of decommissioning planning. Testimony from Southern Cal Edison is especially useful since their San Onofre No. 1 facility is now the fourth oldest commercial nuclear power plant in the country which is still operating. Decommissioning decisions about this facility may have to be made soon.

Pacific Gas & Electric is presently in the process of decommissioning their Humboldt Bay nuclear power plant in northern California. A comparison of decommissioning planning and activities at Humboldt Bay with those of Shippingport should provide the subcommittees insight into many issues, particularly the use of generic cost estimates versus site specific decommissioning cost estimates.

Again, Madam Chairman, I am very pleased to join with you and with Mr. Volkmer, the chairman of my subcommittee, to participate in these farsighted hearings, and I look forward to today's testimony.

Mrs. Lloyd. Thank you, Mr. Packard.

At this time I do ask unanimous consent if any other Members come in a little bit late that their opening statements will be included in the record of the hearing. Without objection, so ordered.

It is certainly a pleasure for me to welcome our first panel of witnesses today, Mr. Bill Voigt, who is Director of the Office of Remedial Action and Waste Technology of the Department of Energy. I must tell you that he is a transplant. He is a former resident of the Third District of Tennessee, so I have a double pleasure in seeing an old friend of mine back today.

We are also glad to see the Honorable Denwood Ross, who is Acting Director of the Office of Nuclear Regulatory Research at the Nuclear Regulatory Commission. We are also happy to have you. I think you are our lead off, Mr. Voigt, so please proceed as you wish.

STATEMENTS OF WILLIAM R. VOIGT, JR., DIRECTOR, OFFICE OF REMEDIAL ACTION AND WASTE TECHNOLOGY, DEPARTMENT OF ENERGY; AND DENWOOD F. ROSS, JR., ACTING DIRECTOR, OFFICE OF NUCLEAR REGULATORY RESEARCH, NUCLEAR REGULATORY COMMISSION

Mr. VOIGT. Thank you, Madam Chairman, Mr. Chairman, members of the committee.[1] With the Chair's permission, I would like to insert the details of my total transcript [2] into the record and just briefly summarize.

Mrs. LLOYD. Without objection, all of our witnesses today may proceed as they like, and their prepared testimony will be made a part of the record.

Mr. VOIGT. Thank you.

The Shippingport Atomic Power Station was constructed on approximately 7 acres of land leased from the Duquesne Light Co. by the Atomic Energy Commission during the mid-1950's. The purpose of the project was to develop and demonstrate pressurized water reactor technology and to generate 72 megawatts of electricity for Duquesne Light customers. The reactor and steam generating portions of the Shippingport station are owned by DOE, with the electrical generating portion of the plant owned by Duquesne Light.

The reactor plant was shut down in October 1982 upon completion of the demonstration project. DOE decided in August 1982 to decommission the Government-owned portion of the station, by immediate dismantlement and subsequent disposal of the radioactive waste, at the Department's Hanford Reservation in the State of Washington. Immediate dismantlement was chosen as the best decommissioning option, to meet the intent of the land-lease agreement, which expires in 1994, and the contract for construction and operation of the plant between DOE and Duquesne Light, which requires that DOE make the premises safe from a radiation standpoint at the end of plant operations.

Because of an estimated $7 million savings and a 10-percent reduction in worker radiation exposures, DOE decided that the reactor vessel would be removed in one piece and shipped together with other radioactive plant components by barge to Hanford for disposal. Shipment by barge will eliminate the need for about 80 low-level waste shipments by trucks traveling across the country.

The first physical decommissioning activities began in September 1985 with the removal of the pressurizer, flash tank, and blowoff tank from the reactor primary coolant system. A summary schedule for the project is provided in chart 1 in my detailed testimony,[3] and leads to completion of the project by April 1990. The current total estimated cost of the Shippingport decommissioning project is $98.3 million, which includes the cost of all preparatory work since 1979, as well as an allowance for inflation.

First, I will discuss the relationship of Shippingport to utility decommissioning needs. This administration expects utilities, the nuclear industry, and such industry-sponsored research organizations as EPRI, the Electric Power Research Institute, to develop the technology to decommission commercial nuclear power plants. The NRC has the responsibility to establish the regulations for decommissioning and the termination of licenses, both from a technical as well as financial viewpoints. State public utility commissions are responsible for determining the appropriate estimated utility decommissioning costs that can be included in the rate base and disposition of the funds collected during the operating life of the plant.

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[1] Mr. Voigt requested that "committee" be changed to "subcommittees."

[2] Mr. Voigt requested that ". . . to insert the details of my total transcript" be amended to read ". . . to insert my total statement . . ."

[3] Mr. Voigt asked that "testimony" be changed to "statement."

DOE will transfer project information and lessons learned from the decontamination and decommissioning of not only Shippingport, but all DOE surplus facilities, and specifically Shippingport and West Valley, which is a nuclear fuel reprocessing plant in the State of New York. This data will be disseminated to the U.S. nuclear industry. We have been able to meet this objective during the course of the Shippingport project in several ways:

First, the number of subcontractors used to perform decommissioning activities has been expanded rather than performing the work entirely with GE [General Electric] and Morrison-Knudsen personnel, thereby increasing the number of qualified contractors and the transfer of the technology to the U.S. industry.

Thorough [4] documentation of the management, planning, engineering, and operations aspects of the project is being done to assure long-term preservation and retrieval of the data. The data and experience are being reported periodically and made available to industry through Federal publications.

Third, a technology transfer activity has been established within the project to enhance the availability of the information and the participating by [5] industry. Utilities and EPRI have been invited to sponsor on-site observers as well as participants in the project. Project personnel are encouraged to present papers at technical societies, as well as and other meetings.[6]

Fourth, DOE is making available, on a no-cost basis, components of the plant and samples of the materials to NRC to provide research data on plant component aging. A reactor pressure vessel sampling project was established by NRC to evaluate samples for changes in mechanical properties. DOE will consider conducting additional tests of decommissioning equipment and technologies as well as techniques at Shippingport on a no-cost, minimal interference basis.

Five,[7] an international decommissioning research program has been established under the auspices of the Organization for Economic Cooperation and Development; that is, the Nuclear Energy Agency [NEA] of that component.[8] Recognizing the interest in the Shippingport project by other countries and the establishment of several significant decommissioning projects in these countries,

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[4] Mr. Voigt requested that "Thorough" be changed to read, "Second, thorough . . ."

[5] Mr. Voigt asked that ". . . participating by . . ." be changed to ". . . participation of . . ."

[6] Mr. Voigt requested that ". . . technical societies, as well as and other meetings." be changed to ". . . technical society and other meetings."

[7] Mr. Voigt changed "Five," to "Finally,".

[8] Mr. Voigt clarified this to read ". . . Organization for Economic Cooperation and Development's Nuclear Energy Agency."

DOE suggested to the NEA in 1983 that this international information exchange program be established, and this occurred in September 1985.

A listing of the countries involved, the projects, and the type of information that is expected to be obtained is provided in chart 2 of my detailed testimony.[9] The reports on these projects will be made available to U.S. industry through Federal publications; and opportunities are available for limited U.S. industry participation, such as visits to the project sites and attendance at exchange meetings. An International Symposium on Decommissioning is being planned for October 1987 in Pittsburgh, PA, and visits to the Shippingport plant will be arranged for the attendees.

I will next discuss the industry's needs for decommissioning of nuclear power plants. Present technology has proven to be quite satisfactory for the decommissioning of nuclear facilities. Although the experience to date is restricted to small facilities, much of the same technology is applicable to the decommissioning of larger facilities. Since present-day reactors will have been operated for longer periods and at higher power levels than decommissioned reactors, some adjustments in the working procedures are necessary to allow for the higher radiation levels, but these higher radiation levels are not expected to require an essentially new approach. For instance, the reactor vessel and internal components must be handled and disassembled by remote operations in both small and large reactors.

Future decommissioning projects will also benefit from the experience obtained with ongoing maintenance and repair work on operating utility reactors and fuel cycle facilities. Experience with accident recovery, such as at Three Mile Island Unit 2, is being obtained under conditions more difficult than encountered in regular decommissioning. All these operations have provided information and experience in working safely and cost-effectively under restrictive conditions.

Although current technology is sufficient for decommissioning industrial-scale facilities, continued development in some areas is desirable, principally to further reduce worker radiation exposure levels to as low as reasonably achievable [ALARA], to further reduce costs, and to further reduce waste volumes. Such areas include decontamination methods, remotely operated equipment for facility and plant equipment disassembly, techniques for minimizing waste generation through treatment, waste volume reduction techniques, and discrimination of radioactivity levels in waste.

Disposal facilities will be needed for the growing volume of decommissioning wastes, beginning in the 1990's in the event reactor lifetime extensions cannot be realized for the older nuclear power plants and deferred dismantlement is not available. The wastes from reactor decommissioning are primarily low-level wastes and can be disposed of in the same or similar facilities as the wastes from reactor operations.

Wide experience already exists on the handling of reactor wastes and new disposal facilities for such wastes will be sited and developed under Public Law 96–573; that is, the Low-Level Waste Policy Act of 1980, as amended.

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[9] Mr. Voigt changed "testimony" to "statement".

A small amount of the decommissioning wastes from commercial reactors will be greater-than-class C low-level waste, as defined in 10 CFR 561,[10] and will require appropriate disposal facilities. As required by Pubic Law 99–240, the Low-Level Waste Policy Amendments Act of 1985, DOE is currently assessing the storage and disposal options required for disposal of this category waste. We plan to submit this report to Congress by January 15, 1987.

Utilities need a defined, stable regulatory environment that allows the necessary technical and financial planning to be accomplished for decommissioning. NRC has published a proposed rule which would establish a basis for the decommissioning and termination of licenses. This proposed rule needs to be promulgated, possibly with some revisions as a result of utility comments. Another need is for each State public utility commission [PUC] to allow an appropriate charge in the rate base to establish the decommissioning fund.

In the technical area, standards for the release of materials for reuse after decontamination and the release of sites for unrestricted use are needed.

I will next discuss utility decommissioning costs. Detailed cost estimates prepared by the Battelle Pacific Northwest Laboratory for the Nuclear Regulatory Commission for dismantling a 1,175-megawatt electrical PWR and a 1,155-megawatt electrical boiling water reactor are approximately $130 million, expressed in 1986 dollars.

Other estimates of decommissioning costs have been made by utilities and their contractors. The cost estimates vary significantly, from $50 to $400 million. Although DOE has not analyzed these estimates, we understand from discussions with the NRC that the more appropriate estimates, when put on a comparable basis, are about $30 million higher than the estimates prepared for NRC.

It is my view that these estimates have to be carefully examined and qualified in each case to assure they are on a common basis; that is, the last core removal from site included or not,[11] all structures and equipment removed or not, and the contingency factor used. Further experience is needed to improve these cost estimates. However, even allowing for uncertainties in the cost estimates and applicable discount rates, decommissioning contributes only a few percent at most to electricity generation costs. DOE has not made a detailed comparison of Shippingport costs with estimated utility powerplant decommissioning costs, but our cost data is publicly available in great detail for utility use.

I will next discuss the application of waste handling and disposal practices from Shippingport to utility activities. The Shippingport waste is being handled and disposed of in a manner that meets the applicable regulations at the least cost to the Government. There are four types of wastes being produced from Shippingport: First, low-level radioactive wastes; second, nonradioactive hazardous wastes; third, mixed wastes containing both radioactive and nonradioactive substances; and fourth, nonradioactive and nonhazardous type wastes.

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[10] Mr. Voigt clarified "561" to be "Part 61".

[11] Mr. Voigt changed this to ". . . that is, whether the last core is removed from site included or not, whether all structures and equipment are removed or not, . . ."

The radioactive wastes are being handled in accordance with DOE directives, transported in accordance with applicable DOT regulations, and disposed of at the DOE Hanford Reservation. This work is very similar to utility activities that would be carried out during decommissioning for most of the radioactive waste. Applicable DOE directives concerning worker radiation exposure levels are essentially identical to that found in both NRC and DOT regulations.

Disposal of utility decommissioning radioactive waste will have to be done at commercial low-level waste facilities, except for a very small amount of waste which is greater than the NRC class C category and will be disposed of at a DOE facility in accordance with Public Law 99-240. Shippingport will not produce any waste that is greater-than-class C.

Non-radioactive hazardous wastes from Shippingport are being disposed of in commercial facilities that are permitted under the Toxic Substances Control Act for asbestos or under the Resource Conservation and Recovery Act [RCRA]. RCRA utilities [12] would dispose of this type of waste from decommissioning in a similar manner.

Mixed waste from Shippingport is being sent to the DOE Hanford disposal area, where it is being temporarily stored on an above-ground pad pending the State of Washington and EPA deciding on disposal requirements. If utilities are disposing of mixed wastes, they would have to follow a similar approach pending clarification of regulations by NRC and EPA.

Non-radioactive and non-hazardous wastes from Shippingport are being disposed of in nearby municipal landfills or sold for scrap for resource recovery.

The Shippingport Station Decommissioning Project is structured and is being carried out to meet the Federal Government's decommissioning obligation under the contract and land lease with the Duquesne Light Co. DOE is providing for the transfer of technical information and lessons learned on its decommissioning activities, including Shippingport, as well as information on international decommissioning projects to the totality of U.S. nuclear industry.

Present decommissioning technology, previously demonstrated on small nuclear facilities, is considered feasible for the larger utility nuclear power plants that will require decommissioning in the future. Some optimization and additional technology development could further reduce worker radiation exposure levels, costs, and waste volumes. Some Shippingport waste handling and disposal is similar in most respects to that expected for utility decommissioning. The one-piece removal of the reactor pressure vessel, for example, may be applicable to some larger commercial reactors and will be applicable for shipping other major radioactive components.

The radioactive waste volumes resulting from the decommissioning of reactors will likely be of the same order of magnitude as the amount of the low and intermediate level waste generated by operating reactors. The estimated Shippingport cost of $98.3 million is comparable with the NRC cost estimate of $130 million for decommissioning a 1,000-megawatt nuclear plant.

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[12] Mr. Voigt changed "RCRA utilities . . ." to "Utilities . . ."

As I mentioned earlier, utility cost estimates vary widely from $50 to $400 million and must be carefully examined to be put on a comparable basis. Even with this large range in estimates, the costs of decommissioning reactors are estimated to be only a few percent of the total electricity generating cost on a discounted basis.

This completes my statement, Madam Chairman, Mr. Chairman, and I would be pleased to answer any questions you may have this time.

[The prepared statement of Mr. Voigt follows:]

STATEMENT OF
WILLIAM R. VOIGT, JR.
DIRECTOR, OFFICE OF REMEDIAL ACTION AND WASTE TECHNOLOGY
U.S. DEPARTMENT OF ENERGY
BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
AND THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

JULY 30, 1986

Mr. Chairman, I am pleased to be here today to present testimony on the Department of Energy's (DOE) Shippingport Station Decommissioning Project (SSDP).

BACKGROUND

The Shippingport Atomic Power Station, located on the south bank of the Ohio River in Beaver County, Pennsylvania, was constructed on approximately seven acres of land leased from the Duquesne Light Company by the Atomic Energy Commission during the mid-1950's. The purposes of the project were to develop and demonstrate pressurized water reactor (PWR) technology and to generate electricity for Duquesne Light customers. The Shippingport station consisted of a 72 megawatt electric (MWe) PWR, a turbine-generator, and associated facilities. The reactor and steam generating portions of the Shippingport station are owned by DOE, with the electric generating portion of the station owned by Duquesne Light. The Shippingport Atomic Power Station achieved criticality in December 1957 and was operated by Duquesne Light for nearly 25 years. Duquesne Light compensated DOE for the steam and marketed the electricity produced by the generator. The

Shippingport station generated over 7.4 billion kilowatt hours of electricity from three cores of fuel until operations were terminated on October 1, 1982. The last fuel was a light water breeder reactor core installed in 1977 to demonstrate the breeding of the uranium-thorium fuel cycle in a light water reactor. The reactor plant was shut down upon completion of the demonstration project. Neither Duquesne Light nor any other utility indicated an interest in continuing to operate the power station to generate electricity.

SHIPPINGPORT STATION DECOMMISSIONING PROJECT

After completing an Environmental Impact Statement (EIS), DOE decided in August 1982 to decommission the Government-owned portion of the station by immediate dismantlement and subsequent disposal of the radioactive waste at the Department's Hanford Reservation in the State of Washington. The decommissioning project involves the immediate dismantlement of the reactor pressure vessel, steam generating equipment, removal of the waste handling and treatment facilities, and cleanup of the remainder of the site to allow unrestricted use from a radiological viewpoint. Once the spent nuclear fuel was removed from the plant in 1984, all of the radioactive waste from the Shippingport plant met the Nuclear Regulatory Commission's (NRC) low-level waste criteria. Immediate dismantlement was chosen as the best decommissioning option to meet the intent of the land lease agreement (which expires in 1994) and the contract for construction and operation of the plant between DOE and Duquesne Light, which requires that DOE "... make the premises safe from a radiation standpoint" at the end of plant operations. Immediate dismantlement costs less than either (1) safe storage followed by deferred dismantlement or (2) entombment followed by deferred dismantlement if the costs are not considered on a discounted basis. Members of the Shippingport operating crew would also be available to assist in the immediate dismantling but would not be if dismantling were deferred for many decades. In addition, immediate dismantlement provides a timely demonstration that a nuclear plant can be decommissioned safely and in a cost-effective manner. Because of an estimated $7 million savings and a 10 percent reduction in worker radiation exposures, DOE decided that the reactor vessel would be removed in one piece and shipped together with other radioactive plant components by barge to Hanford for disposal. A neutron shield tank, which surrounds the reactor pressure vessel and was filled with water during plant operation, will be emptied and filled with concrete grout to provide the necessary shielding for reducing external radiation levels to meet Department of Transportation (DOT) requirements for shipping. Shipment by barge will eliminate the need for about 80 low-level waste shipments by trucks traveling across the country. About 100 truckloads of other low-level waste will be shipped to Hanford.

In 1979, the Department's Richland Operations Office initiated the SSDP by beginning conceptual engineering studies of decommissioning alternatives. More detailed engineering, which established a firm basis for the project in a 12-volume Decommissioning Plan and a reference cost estimate, was completed in 1983. In parallel, an EIS was prepared in accordance with the National Environmental Policy Act and a Record of Decision was issued in August 1982. The General Electric Company (GE) and their integrated subcontractor, the MK-Ferguson Company, were selected through a competitive procurement process. A contract with GE was subsequently signed in February 1984. After removal of the fuel was completed in September 1984, responsibility for the plant was assumed by the DOE on-site project office, supported by GE and a United Nuclear Corporation support staff. During the next 12 months, GE provided maintenance and surveillance of the plant while preparing the necessary manuals, procedures, specifications, and procurement actions needed to commence decommissioning.

The first physical decommissioning activities began in September 1985 with the removal of the pressurizer, flash tank, and blow-off tank from the reactor primary coolant system. During the past year, the work has progressed satisfactorily with no unexpected technical events. Asbestos removal from plant components is almost complete. The removal of other primary loop components has begun. Waste shipments to Hanford began in February 1986. A summary schedule for the project is provided in Chart 1 and leads to completion of the project by April 1990. The total estimated cost of the Shippingport decommissioning project is $98.3 million, which includes the cost of all preparatory work since 1979 and allowance for inflation. Costs on the project to date are very consistent with the engineering estimates.

RELATIONSHIP OF SSDP TO UTILITY DECOMMISSIONING NEEDS

This Administration expects utilities, the nuclear industry, and such industry-sponsored research organizations as the Electric Power Research Institute (EPRI) to develop the technology to decommission commercial nuclear power plants. The NRC has the responsibility to establish the regulations for decommissioning and the termination of licenses, both from technical and financial viewpoints. State public utility commissions are responsible for determining the appropriate estimated utility decommissioning costs that can be included in the rate base and disposition of the funds collected during the operating life of the plant.

DOE will transfer project information and lessons-learned from the decontamination and decommissioning by DOE of surplus facilities--such as Shippingport and the West Valley (New York) Nuclear Fuel Reprocessing Plant--to the U.S. nuclear industry. We have been able to meet this objective during the course of the Shippingport project in several ways:

1. The number of subcontractors used to perform decommissioning activities has been expanded (rather than performing the work entirely with GE and MK-Ferguson personnel), thereby increasing the number of qualified contractors and the transfer of the technology to the U.S. nuclear industry.

2. Thorough documentation of the management, planning, engineering, and operations aspects of the project is being done to assure

long-term preservation and retrieval of the data. The data and experience are being reported periodically and made available to industry through Federal publications.

3. A technology transfer activity has been established within the project to enhance the availability of the information and the participation by industry. Utilities and EPRI have been invited to sponsor on-site observers and participants in the project. Project personnel are encouraged to present papers at technical society and other meetings. The project personnel also inform the local and State of Pennsylvania officials and public regarding project activities.

4. DOE is making available on a no-cost basis components of the plant and samples of the materials to NRC to provide research data on plant component aging. A reactor pressure vessel sampling project was established by NRC to evaluate samples for changes in mechanical properties. DOE will consider conducting additional tests of decommissioning equipment and techniques at Shippingport on a no-cost, minimal interference basis.

5. An international decommissioning research program has been established under the auspices of the Organization for Economic Cooperation and Development's Nuclear Energy Agency (NEA). Recognizing the interest in the Shippingport project by other

countries and the establishment of several significant decommissioning projects in these countries, DOE suggested to the NEA in 1983 that this international information exchange program be established and this occurred in September 1985. A listing of the countries involved, the projects, and the type of information that is expected to be obtained is provided in Chart 2. The reports on these projects will be made available to U.S. industry through Federal publications and opportunities are available for limited U.S. industry participation (such as visits to the project sites and attendance at exchange meetings). An International Symposium on Decommissioning is being planned for October 1987 in Pittsburgh, Pennsylvania, and visits to the Shippingport plant site will be arranged for the attendees.

INDUSTRY NEEDS FOR DECOMMISSIONING NUCLEAR POWER PLANTS

The decommissioning of nuclear power plants and fuel cycle facilities has been studied for many years by experts in the United States and other countries. In addition, there is a significant amount of actual experience with decommissioning facilities and on-going decommissioning research and development. Some of the consensus views that have been expressed by international expert groups are in the reports listed in Chart 3, and are summarized below.

Technology Needs

Present technology has proven to be quite satisfactory for the decommissioning of nuclear facilities. These facilities can be safely decommissioned with no threat to the public and with adequate protection for the decommissioning workers using this technology. Although the experience to date is restricted to small facilities, much of the same technology is applicable to the decommissioning of larger facilities. Since present-day reactors will have been operated for longer periods and at higher power levels than decommissioned reactors, some adjustments in the working procedures are necessary to allow for the higher radiation levels, but these higher radiation levels are not expected to require an essentially new approach. For instance, the reactor vessel and internal components must be handled and disassembled by remote operations in both small and large reactors.

Future decommissioning projects will also benefit from the experience obtained with on-going maintenance and repair work on operating utility reactors and fuel cycle facilities, e.g., removal of steam generators, repair or replacement of primary loop piping and core components; in some cases, these operations are done in higher radiation fields than are encountered in decommissioning. Experience with accident recovery, such as at Three Mile Island Unit 2 (TMI-2), is being obtained under conditions more difficult than encountered in decommissioning. All these operations have provided information and experience in working safely and cost-effectively under restrictive conditions. These operations have also provided experience in decontamination, waste fixation, and waste volume reduction technology, thereby reducing waste transportation and burial costs. DOE is continuing its TMI-2 accident evaluation efforts, transferring the technology and lessons-learned to the nuclear industry.

Although current technology is sufficient for decommissioning industrial-scale facilities, continued development in some areas is desirable, principally to further reduce worker radiation exposure levels to as low as reasonably achievable, to further reduce costs, and to further reduce waste volumes. Such areas include decontamination methods, remotely operated equipment for facility and plant equipment disassembly, techniques for minimizing waste generation through treatment, waste volume reduction techniques, and discrimination of radioactivity levels in waste.

Waste Disposal Needs

Disposal facilities will be needed for the growing volume of decommissioning wastes, beginning in the 1990's in the event reactor lifetime extensions cannot be realized for the older nuclear power plants and deferred dismantlement is not available. The wastes from reactor decommissioning are primarily low-level wastes and can be disposed of in the same or similar facilities as the wastes from reactor operations. The volume of radioactive decommissioning wastes from one reactor is of the same order of magnitude as the volume of wastes from its lifetime operations. Wide experience already exists on the handling of reactor wastes and new disposal facilities for such wastes will be sited and developed under Public Law 96-573, the Low-Level Waste Policy Act of 1980, as amended. The disposal of reactor decommissioning low-level wastes should not require new technical approaches.

A small amount of the decommissioning wastes from commercial reactors will be greater-than-Class C low-level waste and will require appropriate disposal facilities. As required by Public Law 99-240, the Low-Level Radioactive Waste Policy Amendments Act of 1985, DOE is currently assessing the storage and disposal options required for disposal of this category waste. DOE plans to submit this report to Congress by January 15, 1987.

Regulatory Needs

Utilities need a defined, stable regulatory environment that allows the necessary technical and financial planning to be accomplished for decommissioning. NRC has published a proposed rule which would establish a basis for the decommissioning and termination of licenses. Some elements of this proposed rule are the preparation of a decommissioning plan and a cost estimate for each reactor and the establishment of a decommissioning fund to provide for these costs. This proposed rule needs to be promulgated, possibly with some revisions as a result of utility comments. Another need is for each State public utility commission to allow an appropriate charge in the rate base to establish the decommissioning fund.

In the technical area, standards for the release of materials for reuse after decontamination and the release of sites for unrestricted use are needed. The NRC has postponed action on the materials release standard.

The Environmental Protection Agency (EPA) has begun work on criteria for release of sites (40 CFR Part 194).

UTILITY DECOMMISSIONING COSTS

Detailed cost estimates prepared by the Battelle Pacific Northwest Laboratory for the NRC for dismantling a 1,175 MWe PWR and a 1,155 MWe Boiling Water Reactor (BWR) are approximately $130 million, expressed in 1986 dollars. These estimates include the dismantlement and removal of all radioactively contaminated structures and exclude the estimated costs for removing uncontaminated structures and the last core.

Other estimates of decommissioning costs have been made by utilities and their contractors. The cost estimates vary significantly from $50 million to $400 million. Although DOE has not analyzed these estimates, we understand from discussions with the NRC that the more appropriate estimates, when put on a comparable basis, are about $30 million higher than the estimates prepared for the NRC. The total costs of decommissioning are dependent on the sequence and timing of the decommissioning stages used--that is, whether the facility is put in safe storage ("mothballed") to allow radioactivity to decay and then dismantled, or is entombed and then dismantled, or is immediately dismantled. Deferment of dismantling tends to reduce its cost, but the effect is compromised to some extent by the storage costs for surveillance and maintenance. Since both decommissioning and total plant energy generating costs occur over an extended period, the technically correct way to consider these costs are on a basis discounted to a reference time. On a discounted basis, the costs for deferred dismantlement continually decrease as the deferral period increases. These estimates have to be carefully examined and qualified in each case to assure they are on a common basis, e.g., last core removal from site included or not, all structures and equipment removed or not, and the contingency factor used. Further experience is needed to improve these cost estimates. However, even allowing for uncertainties in the cost estimates and applicable discount rates, decommissioning contributes only a few percent at most to electricity generation costs. DOE has not made a detailed comparison of SSDP costs with estimated utility power plant decommissioning costs, but SSDP cost data is publicly available in great detail for utility use.

APPLICABILITY OF WASTE HANDLING AND DISPOSAL PRACTICES FROM SSDP TO UTILITY ACTIVITIES

The SSDP waste is being handled and disposed of in a manner that meets the applicable regulations at the least cost to the Government. There are four types of wastes being produced from the SSDP: (1) low-level radioactive wastes; (2) non-radioactive hazardous wastes; (3) "mixed" wastes, containing both radioactive and non-radioactive hazardous substances; and (4) non-radioactive and non-hazardous wastes.

The radioactive wastes are being handled in accordance with DOE directives, transported in accordance with applicable DOT regulations, and disposed of at the DOE Hanford Reservation. Some of these radioactive wastes are being shipped in about 100 truckloads as low-specific-activity (LSA) waste. This work is very similar to utility activities that would be carried out during decommissioning for most of the radioactive waste. Applicable DOE directives concerning worker radiation exposure levels are essentially identical to that found in both NRC and DOT regulations. The SSDP reactor pressure vessel and core internals, as well as such major components as the steam generators and reactor coolant pumps, will be shipped via barge to Hanford for disposal. The barge shipment will be carried out under DOT regulations. DOE will obtain the necessary permits from the Coast Guard, Corps of Engineers, Panama Canal Zone, and other authorities. This type of waste handling and shipping may be feasible for some utilities whose power plants are near waterways and whose reactor pressure vessels are not too large or heavy to transport to and from the barge, or for major radioactive components other than the pressure vessel (such as steam generators). This could include many of the earliest utility plants that may be dismantled. The disposal site would also have to be accessible to barge shipment such as the commercial disposal facility at Hanford. A steam generator from the Surry nuclear power plant near Gravel Neck, Virginia, was previously shipped to Hanford in this manner, not for disposal but for research purposes, including corrosion testing. This method would reduce the large number of truck shipments that would otherwise occur.

Disposal of utility decommissioning radioactive waste will have to be done at commercial low-level waste facilities, except for a very small amount of waste which is greater than the NRC Class C category and will be disposed of at a DOE facility in accordance with Public Law 99-240. The SSDP will not produce any waste that is greater than Class C. The higher volumetric disposal charge at commercial disposal sites might also affect the economics of one-piece disposal versus cutting up the components to reduce volume. Most of the decontamination and waste volume reduction technology is available and is coming into increased use for handling waste from utility plant operations and maintenance.

Non-radioactive hazardous wastes from SSDP are being disposed of in commercial facilities that are permitted under the Toxic Substances Control Act for asbestos or under the Resource Conservation and Recovery Act. Utilities would dispose of this type of waste from decommissioning in a similar manner.

Mixed waste from SSDP is being sent to the DOE Hanford disposal area, where it is being temporarily stored on an above-ground pad pending the State of Washington and EPA deciding on disposal requirements. If utilities are disposing of mixed wastes, they would have to follow a similar approach pending clarification of regulations by NRC and EPA.

Non-radioactive and non-hazardous wastes from SSDP are being disposed of in nearby municipal landfills or sold for scrap for resource recovery. Utilities would dispose of this type of decommissioning waste in a similar manner.

SUMMARY

The Shippingport Station Decommissioning Project is structured and is being carried out to meet the Federal Government's decommissioning obligation under the contract and land lease with the Duquesne Light Company. DOE is providing for the transfer of technical information and lessons-learned on its decommissioning activities (including Shippingport), as well as information on international decommissioning projects, to the U.S. nuclear industry.

Present decommissioning technology, previously demonstrated on small nuclear facilities, is considered feasible for the larger utility nuclear power plants that will require decommissioning in the future. Some optimization and additional technology development could further reduce worker radiation exposure levels, costs, and waste volumes. The SSDP waste handling and disposal is similar in most respects to that expected for utility decommissioning. The one-piece removal of the reactor pressure vessel, for example, may be applicable to some larger commercial reactors and will be applicable for shipping other major radioactive components. The radioactive waste volumes resulting from the decommissioning of reactors will likely be of the same order of magnitude as the amount of the low and intermediate level waste generated by operating reactors. The estimated SSDP cost of $98.3 million is comparable with the NRC cost estimate of $130 million for decommissioning a 1,000 MWe nuclear plant. Utility cost estimates vary widely from $50 million to $400 million and must be carefully examined to be put on a comparable basis. Even with this

large range in estimates, the costs of decommissioning reactors are estimated to be only a few percent of the total electricity generating cost on a discounted basis.

A view is sometimes presented that an imminent crisis is approaching for decommissioning nuclear facilities because of the many reactors that will reach the end of their licensed lifetimes. DOE believes that these facilities can be safely held in a shut-down mode at reasonable costs. If the spent fuel is removed, the costs to provide additional security are greatly reduced. There is no question, however, that the plant can be maintained in a safe condition. A delay in the removal of the spent fuel or the dismantling of the plant will not adversely affect public health and safety or the environment--in fact, a delay of dismantling for 30 or more years allows radioisotope decay, reduces worker radiation exposure levels, and lowers cost on a discounted basis. In our view, the technology is available to do the job, the costs are a small percentage of the total generating costs and can be provided for by a small set-aside from the rate base, and the wastes are similar to those which will have to be handled from plant operation.

This completes my statement, Mr. Chairman. I would be pleased to answer any questions you may have at this time.

CHART 1

Shippingport Station Decommissioning Project
Project Summary Schedule

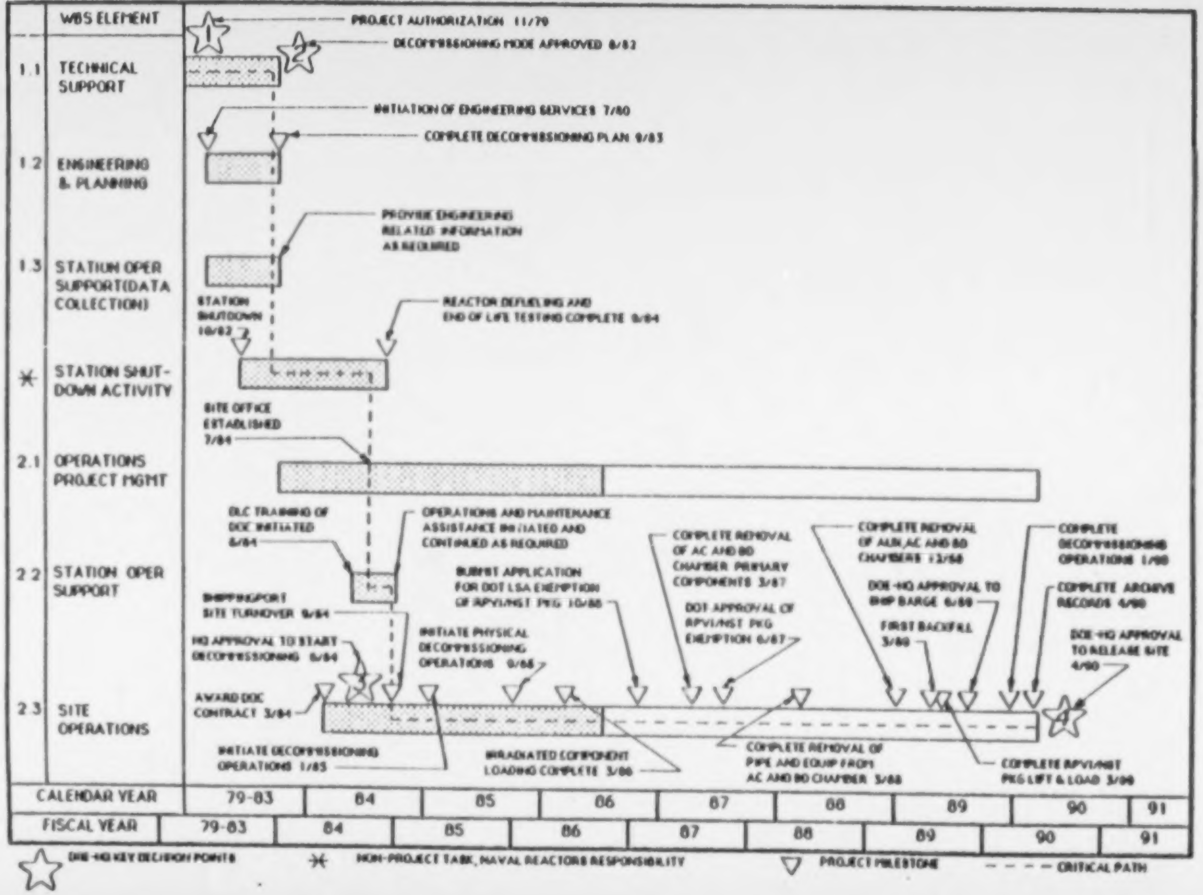

Chart 2

DECOMMISSIONING PROJECTS PARTICIPATING IN THE NEA COOPERATIVE PROGRAMME FOR DECOMMISSIONING

Country	Project	Project Period	Type of Facility/Size	Decommissioning Type	Expected Experience
Canada	Gentilly-1	1984-1986	PHWR-250 MWe	SAFSTOR	Decontaminating using hydrolaser, building isolation techniques, asbestos removal, dry storage of spent fuel.
Federal Republic of Germany (FRG)	Lingen Reactor	1979-	BWR-256 MWe	SAFSTOR	Reactor isolation techniques.
Federal Republic of Germany (FRG)	Niederaich bach Nuclear Power Station	1979-1990	GCHWR-100 MWe	DECON	Dismantlement of the reactor with remote cutting up of the core, vessel, and structures.
France	AT-1	1982-1991	Reprocessing pilot plant for FBR fuel	DECON	Dismantling of highly contaminated plutonium glove boxes and hot cells.
France	G-2 Reactor	1990-	GCR-40 MWe	ENTOMB	Removal of graphite internals entombment techniques.
France	Rapsodie Reactor	1983-1991	LMFBR-40 MWt	ENTOMB	Partial dismantling of an LMFBR

?

Country	Project	Project Period	Type of Facility/Size	Decommissioning Type	Expected Experience
Italy	Garigliano Reactor	late 1980's	BWR-160 MWe	SAFSTOR	Primary coolant loop decon techniques.
Japan	Japan Power Demonstration Reactor	1983-1990	BWR-12.5 MWe	DECON	Concrete and steel cutting techniques, rad inventory calculation, rad measurement techniques, decon techniques.
U. S.	Shippingport	1985-1990	PWR-72 MWe	DECON	Dismantling of reactor systems including one-piece reactor vessel removal.
U. S.	West Valley	1981-1989	Reprocessing - 1 tonne/day	DECON	Decontamination of facility, solidification and glassification of high-level waste.
U. S.	Windscale Advanced Graphite Reactor	1981-1995	AGR-33 MWe	DECON	Methods of remote cutting of reactor steel and concrete; waste packaging

Chart 3

SELECTED REFERENCES TO PREVIOUS STUDIES OF DECOMMISSIONING OF NUCLEAR FACILITIES

1. Decommissioning of Nuclear Facilities, Technical Document, IAEA-179, International Atomic Energy Agency, Vienna, Austria, 1975

2. Factors Relevant to the Decommissioning of Land-Based Nuclear Reactor Plants. Safety Series No. 52, International Atomic Energy Agency, Vienna, Austria, 1980

3. Decommissioning of Nuclear Facilities: Decontamination, Disassembly, and Waste Management, Technical Reports Series No. 230, International Atomic Energy Agency, Vienna, Austria, 1983

4. Decommissioning of Nuclear Facilities: Feasibility, Needs, and Costs, Report by an Expert Group, Organization for Economic Cooperation and Development, Nuclear Energy Agency, to be published in 1986

5. Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, U.S. Nuclear Regulatory Commission, January 1981 (NUREG-0586)

6. Storage with Surveillance vs. Immediate Decommissioning for Nuclear Reactors, Proceedings of an NEA Workshop: OECD, Nuclear Energy Agency, Paris, 1985

7. Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor. Battelle Pacific Northwest Laboratories for the NRC, 1978 (NUREG/CR-0130, Add. 3)

8. Technology, Safety, and Costs of Decommissioning a Reference Boiling Water Reactor Power Station, Battelle Pacific Northwest Laboratory for the NRC, 1980 (NUREG/CR-0672)

9. Nuclear Reactor Decommissioning: An Analysis of the Regulatory Environments, Robin A. Cantor, Oak Ridge National Laboratory for the DOE Energy Information Administration, report being printed and distributed July 1986

Mrs. Lloyd. Thank you very much, Mr. Voigt. Dr. Ross, we look forward to hearing from you now.

Mr. Ross. Members of the subcommittees, I, too have a prepared testimony, and I'll briefly summarize.

I am pleased to present testimony concerning nuclear power plant decommissioning, and will address the NRC views on the four areas detailed in the committee letter. From the NRC perspective, the industry needs are to have necessary information to comply with our decommissioning rules. The current proposed rules have an emphasis on the licensee having adequate financial assurance to pay for the cost of the decommissioning.

A proposed rule requires submittal by the licensee of a plan and periodic updates for funding decommissioning costs for reactors 2 years after the rule becomes effective. The plan should contain an estimate of the cost of decommissioning, with sufficient detail to allow the NRC to ascertain that the methodology and costing information is reasonable, and a mechanism for fund collection and accumulation to assure that the estimated amount of funds required for decommissioning will be available at cessation of reactor operation.

When the licensee has provided satisfactory information on the funding plan particulars, the NRC will approve the plan as a condition of its license. At the end of reactor operations, detailed decommissioning plans must be submitted which contain, in addition to technical particulars, a cost estimate for the decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion at [13] decommissioning.

I would like to make it clear that this discussion is from a proposed rule; the actual requirements that must be met will be known and effective after Commission final action is taken on this rule. With respect to transfer of information and technology to the utility industry from the Shippingport program, NRC will continue to collect and publish Shippingport decommissioning data on cost, radioactive exposure, and waste volumes so that this information may be used by industry to prepare and by NRC to evaluate licensee decommissioning plans for large reactors.

Although Shippingport is not a reactor of large power output by today's standards, it is larger than any dismantled and decommissioned thus far in the United States and many of the activities are directly applicable or may be projected reliably in [14] larger reactors.

As to the extent to which waste handling and disposal practices are expected to parallel similar commercial activities, there are some Shippingport decommissioning activities which may not parallel commercial reactor decommissioning, such as the previously mentioned intact removal of the reactor pressure vessel, rather than the more likely commercial situation of cutting up the vessel and appropriate packaging. Also, conditions of acceptance of the shipments and various wastes from Shippingport by Government waste disposal facilities may differ from those of the commercial waste disposal sector. Nevertheless, there are many Shippingport activities where valuable information can be obtained, such as the type and volume of waste generated from specific activities, their characterization in terms of low-level waste streams and their packaging and shipment particulars.

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[13] Mr. Ross changed "at" to "of".

[14] Mr. Ross changed "in" to "to".

Finally, how does the cost of decommissioning the Shippingport facility compare to that of commercial facilities? Present DOE estimates, as you have just heard, for decommissioning Shippingport is about $100 million. Our current estimate, that is, 1986, for decommissioning a large commercial reactor that was made by a contractor, PNL [Battelle Pacific Northwest Laboratories], is about $130 million. It should be remembered that decommissioning of Shippingport is a demonstration project of DOE and has an objective of information gathering for DOE, NRC, other government agencies and industries.

The decommissioning of a commercial reactor would not necessarily have these information gathering objectives, and you would expect differences in costs because of this. We expect the costs of the Shippingport activity can be effectively used to estimate the cost of similar tasks involved in decommissioning larger reactor, and we plan to use this information in this way to evaluate licensee decommissioning plans.

This completes my summary, and I am also ready for questions.

[The prepared statement of Mr. Ross follows:]

PREPARED TESTIMONY

SUBMITTED BY

UNITED STATES NUCLEAR REGULATORY COMMISSION

TO THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

COMMITTEE ON SCIENCE AND TECHNOLOGY

CONCERNING

DECOMMISSIONING

SUBMITTED: JULY 30, 1986

Chairman Lloyd and Chairman Volkmer:

I am pleased to present testimony concerning nuclear power plant decommissioning. My testimony will address the NRC views on the needs of the utility industry relative to decommissioning, the transfer of information and technology to industry from the Shippingport program, the cost of decommissioning the Shippingport facility compared to commercial facilities and the extent to which waste handling and disposal practices from Shippingport's decommissioning are expected to parallel similar commercial activities.

From the NRC perspective, the industry needs to have the necessary information to comply with NRC decommissioning rules. Current proposed rules have an emphasis on the licensee having adequate financial assurance to pay for the cost of decommissioning.

The proposed rule requires submittal of a plan for funding decommissioning costs for reactors two years after the rule becomes effective. The plan should cover two major aspects. First, an estimate of the cost of decommissioning must be provided by the licensee with sufficient detail to allow the NRC to ascertain that the methodology and costing information is reasonable.

Second, the licensee must provide a mechanism for fund collection and accumulation to assure that the estimated amount of funds required for decommissioning will be available at cessation of reactor operation. In addition, because it is recognized that economic situations as well as technology can continually change, periodic updates to the funding plan must also be specified. When the licensee has provided satisfactory information on the funding plan particulars, the NRC will approve the plan as a condition of its license.

The proposed rule furthermore requires that at or about five years prior to the projected end of operation, the licensee must submit a cost estimate for decommissioning based on an up-to-date assessment of the actions necessary for decommissioning and if necessary submit plans for adjusting levels of funds assured for decommissioning. This is to assure that actual decommissioning situations have been accounted for (such as waste disposal problems) and that funds accurately reflect the real decommissioning situation at this time. Finally, at the end of operations detailed decommissioning plans must be submitted which contain, in addition to technical particulars, a cost estimate for the decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning.

I would like to make it clear that the preceding discussed a proposed rule. The actual requirements that must be met will only become known and effective after Commission action to publish the rule in effective form.

With respect to transfer of information and technology to the utility industry from the Shippingport program, it should be noted that Shippingport is only one source of decommissioning information. Information on the costs of decommissioning currently are based on engineering estimates derived from costs of small reactor decommissionings (e.g., Elk River) and other industry experience such as decontamination and dismantling of small research and test reactor components. We have made this information available by publication of a series of documents (NUREG reports) for use by the public, industry and Government.

As decommissionings occur, such as at Shippingport, NRC will continue to collect and publish these data so that this information may be used by NRC and industry to estimate costs, doses and waste volumes for large reactors.

The NRC has two contractors, United Nuclear Corp. (UNC) and Battelle Pacific Northwest Laboratory (PNL) currently obtaining data from Shippingport. UNC is collecting relevant data on ongoing decommissioning activities and PNL is doing detailed sampling and analysis to characterize the distribution, quantity and type of radioactive contamination present at Shippingport. This information will be available to industry through NRC reports.

Although Shippingport is not a reactor of large power output by today's standards, it is larger than any dismantled and decommissioned thus far in the United States and many of the decommissioning activities are directly applicable or may be projected reliably to larger reactors. NRC needs sufficient information to evaluate a licensee's funding plan that contains his estimate for the cost of his plant specific decommissioning activities. In addition, information from Shippingport that we expect could help us to evaluate decommissioning plans for large nuclear power plants would include, on a per key task basis: worker skills and manhours, labor and equipment costs, occupational dose, and waste characterization and quantity. Tasks must be broken down sufficiently so that this information can be analyzed and modified as applicable for evaluating a licensee's plans for decommissioning. For example, for a particular operation such as removal of a Shippingport valve, data on key elements relating to this valve removal should be collected so that they can be modified for application to large reactor valve removal.

As to the extent to which waste handling and disposal practices are expected to parallel similar commercial activities there are some Shippingport decommissioning activities which may not parallel commercial reactor decommissionings such as the presently planned intact removal of the reactor pressure vessel rather than the more likely commercial situation of cutting up the vessel and appropriate packaging. Also, conditions of acceptance of the shipments of various wastes from Shippingport by Government waste disposal facilities may differ from those of the commercial waste disposal sector. Nevertheless, there are many Shippingport activities where valuable information can be obtained such as the type and volume of waste generated from specific activities, their characterization in terms of low level waste streams and their packaging and shipment particulars.

Finally, how does the cost of decommissioning the Shippingport facility compare to that of commercial facilities? Present DOE estimates for decommissioning Shippingport is $100.5 million. A current estimate for decommissioning a large commercial reactor that was made by our contractor, PNL, is $130 million. It should be remembered that the decommissioning of Shippingport is a demonstration project of the Department of Energy (DOE) and has an objective of information gathering for the DOE, NRC, and other Government agencies and industry. The decommissioning of a commercial reactor would not necessarily have these information-gathering objectives. One would expect differences in cost because of this.

Moreover, there are other differences that additionally impact these cost comparisons. As mentioned earlier, the reactor pressure vessel is shipped intact, along with other radioactive wastes, to Hanford. It is expected that the pressure vessel for commercial plants will be cut up before being shipped. The present plan requires that the entire Shippingport facility be demolished, all debris removed and the site restored to its original state. There may be other actions associated with the decommissioning of Shippingport that may be different than those used in decommissioning a commercial reactor. Industry, DOE, and NRC must be alert to potential differences so that they can be accounted for when applying or modifying Shippingport costs.

The NRC expects that on a per key task basis, the costs of the Shippingport activity can be effectively used to estimate the cost of similar tasks involved in decommissioning larger reactors and is planning to use this information in this way for evaluating licensee decommissioning plans.

Mrs. LLOYD. Thank you very much, Dr. Ross, as well.

We will be leaving at the second bell, because we do have a vote, but Mr. Volkmer should be back soon, so we will have a slight break pretty soon in our hearings.

Mr. Voigt, as you know, this subcommittee that I chair instructed the DOE to work with Shippingport to establish a technology transfer activities related to the remedial action program. Now the purpose of this work was to get as much information as possible so that we could work with the utilities to really understand what they may be encountering at the turn of the century when some of their plants will have to be decommissioned. But, really, it seems to me that they haven't shown a great interest in participating in this technology transfer. It seems to me it really hasn't been received as well as the subcommittee hoped that it would be.

I would like for you to give us your reaction to their, really, lack of response to what is going on at Shippingport from the utilities.

Mr. VOIGT. Well, Madam Chairman, there were three surveys that were performed in attempting to ascertain interest on the part of industry in Shippingport technology. The first, in 1984, of 46 utilities, 34 responded, and 8 expressed an interest to participate and/or observe.

In 1985 we did another survey—34 were contacted, 14 responded, 2 had an interest to participate and observe, which is a reduction from the previous survey.

In 1986 we did another survey where 56 were contacted, and we have only had 11 responses. That was domestic. I think it is fair to say that there is a good deal of foreign interest in our decommissioning and our decontamination technology, more so than the current——[15]

Mrs. LLOYD. I was interested in the level of foreign participation as well.

Mr. VOIGT. The participants—in fact we have, I believe, on board right now one Korean participant. There have been a number of queries from other countries. As we get into this international collaboration that I mentioned earlier——[16]

Mrs. LLOYD. What country has shown the greatest interest in the activities?

Mr. VOIGT. I think thus far it has been the Far East—Japan, Korea. In fact, Mr. Crimi, in his testimony, might touch on that. Beside the Far East, it has been France, Germany, the United Kingdom—the ones that have major reactors which are also being decommissioned.

Mrs. LLOYD. Why do you think the foreign interest is greater than the interest in the United States?

Mr. VOIGT. Because right now they are undergoing similar type decommissioning activities in Europe as well as the Far East, as contrasted to the present status of decommissioning plants in the United States.

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[15] Mr. Voigt changed "current" to "domestic".

[16] Mr. Voigt clarified his response to read "We have, I believe, on board right now one Korean participant. There have been a number of queries from other countries. As we get into this international collaboration—"

Mrs. Lloyd. What do you think we can do to enhance the interest by our domestic people?

Mr. Voigt. As we progress and get into some of the more hands-on details of Shippingport, although we are doing very much right now.[17] We have moved a lot of the major components, but as we get into it, when we start the lifting of the reactor pressure vessel, and what have you, this might cause some additional interest by our utilities. But we have done everything possible.

We have had held two international symposiums on decommissioning. One was held in Seattle. I mentioned the one that we are going to have next year in Pittsburgh, so hopefully we will get some interest there as well.

Mrs. Lloyd. We are going to have to have a slight recess in the hearings until Mr. Volkmer gets back, and we apologize for this delay.

[Recess.]

Mr. Volkmer [presiding]. The subcommittees will resume the hearing. I would like to have a few questions, Mr. Voigt. As I understand, the EIS [environmental impact statement] was developed for Shippingport under the assumption that the reactor vessel would be segmented and shipped and waste be sent to the Savannah River disposal facility. Is that correct?

Mr. Voigt. To Hanford, to our Hanford site, Mr. Chairman.

Mr. Volkmer. The original EIS, or do you know?

Mr. Voigt. The final EIS was developed on the basis of a one-piece shipment going to Hanford.

Mr. Volkmer. In May 1981 was there a study made by the Nuclear Energy Services entitled, "Engineering Analysis of One-Piece Versus Segmented Removal of the Reactor Vessel."

Mr. Voigt. Yes, sir, there was an analysis done. This was the savings of $7 million that I mentioned earlier.

Mr. Volkmer. Could you supply us a copy of that study?

Mr. Voigt. I would be glad to, Mr. Chairman.

[The study was submitted and is retained in subcommittee files.]

Mr. Volkmer. All right. The study provided for an 11-month schedule reduction for a single unit removal?

Mr. Voigt. That is correct.

Mr. Volkmer. And the $7 million savings.

Mr. Voigt. As well as a reduction of 100 man-rem in terms of exposure.

Mr. Volkmer. OK. Now did the fact that the Shippingport reactor had been decontaminated in prior times impact the cost estimates for decommissioning alternatives considered in the 1982 environmental impact statement?

Mr. Voigt. Could you repeat the question?

Mr. Volkmer. Well, let me turn it around. First, did the fact that it had been decontaminated before reduce the radioactivity presently at the reactor vessel and parts that were cleaned up?

Mr. Voigt. I can say, Mr. Chairman, that the fact that the radiation levels in the plant itself when we took over the plant for decommissioning and further decontamination were relatively low, so from that standpoint it helped out in terms of exposure levels, what have you.[18] It made it less cumbersome.

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[17] Mr. Voigt expanded this to read ". . . right now, there should be more interest".

Mr. **Volkmer**. That is what I am getting at. Now, let's say you had a higher radiation inventory, would that have impacted in any way, do you believe, on the choice of whether to segment the reactor pressure vessel or to remove it in one piece?

Mr. **Voigt**. No, sir. In my view it would not have.

Mr. **Volkmer**. OK. Now, I have been informed that much of the technological development remaining in the area of decommissioning involves increased emphasis on robotics and better decontamination of reactor materials. Do you agree with that?

Mr. **Voigt**. Yes, sir.

Mr. **Volkmer**. And what work at Shippingport will be done in these two areas?

Mr. **Voigt**. Well, in terms of basic R&D, none of it will be done at Shippingport. What we are drawing upon is technology that has already been developed in other segments of the industry.

In other words, we are drawing upon efforts. We used quite a bit of robotics in our West Valley decontamination/decommissioning facility. It has been widely through industry, as well as overseas.[19] So we are drawing upon that wealth of technology in terms of what we use at Shippingport.

Mr. **Volkmer**. Approximately when will the first full-scale nuclear power plant reach terminal status. Let's say a better than 600-megawatt facility.

Mr. **Voigt**. I have those numbers.

Mr. **Volkmer**. That's all right. Take your time. I don't have each one specifically. I have some generalization of a total that will come due, but they don't tell me anything as far as specifics. I know we had some powerplants between the 65 and 70 range, I think, that might be in that category.

Mr. **Voigt**. I do have that, Mr. Chairman.

Mr. **Volkmer**. I know you can't anticipate every question.

Mr. **Voigt**. The schedules—these are plants licensed before 1985.[20]

Mr. **Volkmer**. Yes.

Mr. **Voigt**. It is the late 1990's, the year 2000 before any one of any magnitude comes scheduled for any decommissioning. So there is a lot of time between now and then is what I am saying.[21]

Mr. **Volkmer**. You mentioned in your statement that it may be possible, if the facility is near a river or something, that they may be able to use the—taking the whole reactor in one piece and shipping it out. Now, on these larger reactors, say, in the 600- to 1,000-megawatt range, do you envision that those will still be able to be moved in one piece?

Mr. **Voigt**. It is really a function of the economics, Mr. Chairman, the economics in terms of that required to disassemble or cut it up into small pieces versus the volume required within the framework of disposing this in a commercial low-level waste disposal site.

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[18] Mr. Voigt requested deletion of the phrase ". . . what have you".

[19] Mr. Voigt altered this paragraph to read "We used quite a bit of robotics in our West Valley decontamination/decommissioning facility. It has been widely used throughout industry, as well as overseas . . ."

[20] Mr. Voigt changed "1985" to "1965".

[21] Mr. Voigt clarified this response: "It is the late 1990's, the year 2000 before any one of any magnitude is scheduled for decommissioning".

There is a large push on now to reduce volumes going to these commercial low-level sites, so it is really a function of what the economics is to the generator. So it can't be said categorically one way or the other that it would not be economic to ship it as a single vessel.

Mr. **Volkmer**. In other words, you believe, though, that physically it could be able to do so by a combination of barge, truck and rail?

Mr. **Voigt**. Probably more by barge than either of the latter two.

Mr. **Volkmer**. But I mean you are going to have to get it to the barge some way or the other.

Mr. **Voigt**. That's right, but most of the plants are on large bodies of cooling [water] one way or the other.[22]

Mr. **Volkmer**. OK. I believe that it would be safe to say that DOE and NRC, Dr. Ross, are assuming that in this time frame by the 1990's that we will have low-level nuclear waste sites available for decommissioning.

Mr. **Ross**. Yes, that is a fair assumption that it would go together. However, we have had a lot of dialogue lately with the regulated industry on plant life extension, and economics may be pushing the other direction. These anticipated decommissioning dates may be going 10 or 20 years more in the future than we now see them. That seems to be a very real possibility. The connection with low-level waste availability may not be as crucial as it would otherwise seem if plant life extension is a reality, and I think it is.

Mr. **Volkmer**. Well, as soon as I get finished my question with Dr. Voigt I will go into that with you, because I do have some questions into that.

As I understand it from your testimony, Dr. Voigt, that all the radioactive wastes at Shippingport will be below C level, grade C; is that correct?

Mr. **Voigt**. Yes, sir.

Mr. **Volkmer**. That includes the reactor pressure vessel.

Mr. **Voigt**. That includes the reactor pressure vessel.

Mr. **Volkmer**. And you have done, of course, a radiation inventory on the vessel.

Mr. **Voigt**. Yes, sir.

Mr. **Volkmer**. Could we have a copy for our records of the radioactive isotopes that are presently shown in the inventory?

Mr. **Voigt**. Yes, I would be glad to make that available if they are available.

[The material follows:]

RADIONUCLIDE INVENTORY OF THE REACTOR PRESSURE VESSEL, INTERNALS, NEUTRON SHIELD TANK AND LWBR COMPONENTS

The estimated inventory of radio activity contained in the Reactor Pressure Vessel/Neutron Shield Tank package as of 4-01-89 is summarized as follows:

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[22] Mr. Voigt changed this to "... large bodies of cooling water".

Isotope	Activity (curies) vessel, internals	LWBR components	Total
Iron-55	1,970	46	2,016
Cobalt-60	3,820	38	3,858
Nickel-63	580	6	586
Total	6,370	90	6,460

These values were derived from previous referenced work, and are shown to be comparable to the limits for Low Specific Activity (LSA) shipments.

Mr. VOLKMER. Now, Mr. Ross, in reviewing your testimony it indicates that the Commission expects that most commercial operators will cut up or segment their reactor vessels; is that correct?

Mr. ROSS. Yes, sir, that's what we said.

Mr. VOLKMER. And there probably won't be much utilization, just what is being done at Shippingport, with the reactor vessel.

Mr. ROSS. There has been some work on cutting vessels up by plasma torches other than, of course, at Shippingport, and there has been also some work on cutting steam generators with the same sort of material, so I think the technology for remote segmenting exists. It is just not being demonstrated at Shippingport.

Mr. VOLKMER. Will we be following what is being done, I believe, in West Germany—they are going to segment a reactor pressure vessel?

Mr. ROSS. Very definitely. We are partners. There is a decommissioning project at a reactor called Gundremmingen, and we are research partners with them for the same purpose with our Shippingport, to get embrittlement data on the pressure vessel's steel. We meet regularly. In fact, the principal architect of that project will be visiting me next week. I visited him last month, so we have regular technology meetings.

We are also partners with Japan and the Japanese JPDR demonstration project on decommissioning.

Mr. VOLKMER. Now, will this technology that is being developed be available to the nuclear industry?

Mr. ROSS. Yes, yes, it will.

Mr. VOLKMER. And firms and contractors that are involved in decommissioning?

Mr. ROSS. Yes, we will publish our information. I think it is fair to say that if they really want to know how to do it, though, they won't get it from reading our reports. They will go over and talk with people that did it.

Mr. VOLKMER. Now, does the amount of contamination, radioactivity and the amount of different types of isotopes that are present increase the cost of decommissioning?

Mr. ROSS. Certainly, to a degree. Some of the activities, I think, would be affected by scale and some would be affected by the waste stream activity. The sheer volume of decontamination is certainly a factor of scale, and there will be more cubic meters of stuff generated for the bigger facilities. Some activities, I think, will be the same type of labor activities for big and small, so it is a mix.

Mr. VOLKMER. But you also have the number of man-hours because a person could be subject to labor force for individuals, would you not, and that would change as the amount of exposure?

Mr. Ross. Yes, sir. On a scale—if you have to remove a small valve or a big valve, the labor might be about the same, but certainly you are going to have a lot more curies of activity in the larger, older systems.

Mr. VOLKMER. That's what I mean.

Mr. Ross. That's going to take more man-hours just to decontaminate, and that's where it would be a sliding scale.

Mr. VOLKMER. OK. Now, do you envision entombment as an alternative for decommissioning a commercial reactor?

Mr. Ross. We permit it, but it is not unlimited. Our proposed rule says if it is good cause you could bottle the system up, and we use the number of about 100 years, but we don't think indefinite entombment or perpetual entombment is an alternative. Our rule clearly says there is a limit, and we suggest it is about 100 years, and the basis is the ability to guarantee some kind of institutional control. Beyond that, maybe, there won't be any viable utility to be responsible.

Mr. VOLKMER. Do you envision in the future that entombment will be a methodology that will be utilized by the nuclear industry?

Mr. Ross. It will be speculation on my part, and I'd say in some instances, but I don't know if they would go for the 100 years. I suspect it would be a very complex answer.

If you look at a large utility like Commonwealth Edison, they had four plants, four boiling reactors come on line in about the same 2-year period. I would not think they would want to decommission all four of those at once. I could see them, perhaps, bottling one up and then moving—maybe the labor force going from place to place. That is the way they built the plant, and that might be the way they would decommission it.

Mr. VOLKMER. In other words, they really wouldn't necessarily entomb it, they may just isolate it until they could get to it.

Mr. Ross. Right.

Mr. VOLKMER. Which is different than entombment.

Now, we don't have data for a commercial reactor radiation inventory following a 30- to 40-year operating lifetime. In other words, we haven't had any for a large commercial reactor, right?

Mr. Ross. That's correct.

Mr. VOLKMER. We just haven't had any history of that.

How did you develop your 30- to 50-year estimate for the timing of deferred dismantlement?

Mr. Ross. The half-life of the isotopes are well known, and you can project because there is a lot of activity in measurements of contamination around the primary system that, I think, are reasonably well known and would not be likely to change. I think we got most of the useful data from the PWR [pressurized water reactor] steam generator problems where you had to measure doses and repair and replace tubes, so there is a lot of information on the time dependence of radioactivity buildup. The fact that they haven't run but 15 years instead of 40 I don't think is particularly relevant.

Mr. VOLKMER. All right, then that gets me to the question of—you mentioned earlier the possibility of renewal of some of these licenses for another 10 years or a longer period, and the question there is the buildup of the isotopes within the vessel itself and the activation. You don't see any major change in that?

Mr. Ross. No; I don't see anything major. It certainly will build up, and there would be more activation products, some more contamination or "crud" or that type of activity that migrates, but I don't see it being major, no.

Mr. Volkmer. What about the question you mentioned you are studying, and I think you are way ahead of us on it, the question of embrittlement of the pressure vessel with this constant bombardment. Do we know now what is the safe operating life of a pressure vessel?

Mr. Ross. It depends on the vessel. Some of the plants that came into operation in the early seventies, if they want to extend plant lifetime, would probably have to reheat the vessel up to anneal out the radiation damage. This has never been done on a large reactor, and there is a theory that it can be accomplished in a small scale task. If they were unwilling and unable to reheat the vessel, they probably could not extend the vessel lifetime.

This depends on the method of construction. It is very plant dependent. There is an interest around the world in what they call this in-situ annealing as a method of extending plant lifetime. This is for the pressurized water reactor only.

Mr. Volkmer. What about the boiling water reactors?

Mr. Ross. Their vessel is sufficiently big and far enough away from the core. In general, radiation embrittlement is not a problem for them.

Mr. Volkmer. All right. On the newer ones—let's say the ones that have come in since, say, 1975, do you envision any problem with embrittlement in those pressure vessels?

Mr. Ross. I don't think so. The problem I ran into is that, inadvertently, we are getting higher concentrations of copper into the weld material than they should have, and then later data showed that this promotes or aggravates the embrittlement phenomenon. Depends on when they got control of the process and eliminated the copper.

Some of the plants that came on line in the late seventies unfortunately may have bought their vessel many years ago, so we just have to look at the weld properties.

Mr. Volkmer. Either one of you can answer this: is there any probability that, following completion of the decommissioning at Shippingport, that we would be able to utilize that technology very soon thereafter for decommissioning of a commercial plant?

Mr. Voigt. Well, in speaking from the Department's view, I think that our technology is very extrapolatable to a large-scale plant. So, from that standpoint, the only question is the single vessel lift as to what degree that would be.

Mr. Volkmer. My question, Mr. Voigt, is do we have a plant that is going to be decommissioned within the near future to utilize it right away using the technology, or are we going to wait until 1990's?

Mr. Voigt. The only plant I can think of that will be decommissioned—and, again, I am not sure—in fact, one of the witnesses this afternoon is Humboldt Bay.[23] I think that goes into safe storage.

Mr. VOLKMER. They intend to leave it in safe storage for some time.

Mr. VOIGT. So I can't think of another plant that would be up in the late 1990's or the early 2000's. I am talking domestically, now.

Mr. VOLKMER. Now, Dr. Ross, I would like to get into the question of the cost of decommissioning. The Commission, in their proposal, I understand, came up with, I believe—it is $100 million approximate?

Mr. ROSS. One option, you could take the certification amount, or you could come up with your own amount. That is correct.

Mr. VOLKMER. Now, have the comments received by the Commission as a result of that supported this figure?

Mr. ROSS. To a degree. Of course, you have heard already that there have already been some fairly large estimates in the billions of dollars. We probably will revise that figure upward some on the basis of the comments. We have gotten some new information. Some of it came from industry on how to calculate and we didn't take into account site differences.

I don't think it will go up much, but my guess is in 1986 it might go up to $150 million. I don't think that is an important thing in the overall scheme.

Mr. VOLKMER. That is the next question. Why do we include a figure in the proposed rule at all?

Mr. ROSS. The initial concern is that people might underestimate, not collect enough money, and now it looks like maybe the industry is going another way, and I understand there is public utility commission considerations that go beyond us, or at least beyond me. I think the preferred path would be, "let each utility justify its own costs," since everyone seems to agree that there are site differences that may make a true difference and go with that.

Mr. VOLKMER. Perhaps if the NRC would emphasize the fact that the State utility commission that regulates should require site-specific decommissioning cost figure for each utility, and then let them work that out.

Mr. ROSS. That might be a better solution. Our schedule calls us to finish our comment analysis in the next several months.

Mr. VOLKMER. But if you put both of those in, and say if you are using a figure, say, at least so much.

Mr. ROSS. A lower limit might take care of all the problems.

Mr. VOLKMER. Do you monitor the availability of funds for decommissioning among the licensees?

Mr. ROSS. We will. Pursuant to this rule, we will.

Mr. VOLKMER. So after January 1987, or whenever the rule finally becomes final, anyway.

Mr. ROSS. They will file their plans and we will make these a condition of license, and they will have to be updated, so we will be monitoring, yes.

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[23] Mr. Voigt clarified this response to read, "The only plant that I can think of that will be decommissioned—and, again, I am not sure—is Humboldt Bay."

Mr. **Volkmer**. But you have no preference as far as in the decommissioning funding of the methodology used in funding, whether it is internal or external.

Mr. Ross. Yes, we do have a preference. We had a financial consultant do a very readable short analysis of the various methods,[24] and as you might expect, they put internal reserve at the bottom of the list, and our rule, in effect—if it is your only plant that you are running, it categorically excludes internal reserves.

The consultant, Professor Siegel from Wharton, listed the different ways and order of the external reserve—of which ones from a banker's view, I guess, or an economist's view, which would be preferable. We will permit, however, any one of the four methods, except, as I said, internal reserve would not be permitted for the smaller utility. Economically, some are better than the others.

Mr. **Volkmer**. Well, who makes the final determination on that? Does the State regulatory commission?

Mr. Ross. I don't know. We don't. We list what is preferable, and they come in and say what they are going to do.

Mr. **Volkmer**. So you are not going to make a requirement for each utility.

Mr. Ross. Not for a method, no. They have to have a method and describe it, and that's their choice.

Mr. **Volkmer**. At this time, I yield to the gentleman from California.

Mr. **Packard**. Thank you, Mr. Chairman. I believe you were asked earlier about foreign plants—how many foreign plants are operating now, compared to the number of U.S. plants? Do you have any general figures?

Mr. Ross. I'd say several hundred. We operate 100 plus, like 102. I think there are 350 other reactors.

Mr. **Packard**. So there are far more plants outside the United States than inside.

Mr. Ross. That's correct.

Mr. **Packard**. Has there been any decommissioning of foreign plants, commercial plants up to this point?

Mr. Ross. Not of the size we are talking about.

Mr. **Voigt**. Not strictly commercial plants as such.

Mr. **Packard**. So foreign technology and decommissioning is no further ahead, or perhaps trailing behind, the U.S. technology?

Mr. **Voigt**. I'd say about equal.

Mr. **Packard**. So we are both entering into a phase now.

Mr. **Voigt**. Yes, everybody.

Mr. **Packard**. On the cost issue, how many State public utility commissions have been allowing the collection of funds for decommissioning?

Mr. Ross. I don't know.

Mr. **Voigt**. I can't answer that.

Mr. **Packard**. Are there any issues that the State public utilities commissions have expressed concerning decommissioning and the funding of them, collection of funds, the monitoring?

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[24] J.J. Siegel, *Utility Financial Stability and the Availability of Funds for Decommissioning*. NUREG/CR-3899, September 1984 (Washington: Nuclear Regulatory Commission).

Mr. VOIGT. It is my understanding, and it is only my understanding, Congressman, that some utilities have experienced some problems with the PUC's in terms of—including decommissioning [25] in the rate base.

Mr. PACKARD. What is the most expensive part of decommissioning?

Mr. VOIGT. I think it is principally labor. It is very labor intensive in the framework of——

Mr. PACKARD. What is the most sensitive or most difficult part?

Mr. VOIGT. I would expect it would be the radiation fields which would subject [26] a lot of people to be required, and that's why it is so important to do a good decontamination.

Mr. PACKARD. One of the criticisms is that Shippingport is unlike most of our commercial plants in terms of size and complexity, plus there have been some things done there that have changed the nature of decommissioning of a larger commercial plant. What is your response to that in terms of learning what we need to learn to prepare ourselves for the decommissioning of other plants?

Mr. VOIGT. I believe the information from Shippingport will be very transferable to industry, removing of valves,[27] of pumps, of steam generators, of pressurizers. There are a lot of systems in Shippingport that are synonymous to systems in a large scale, commercial nuclear powerplant, so all of that would be extrapolatable.

Mr. PACKARD. And carrying that question a little further, most plants are unique, some of them even one of a kind. Is the technology for decommissioning—is it transferable, do you feel, from one unique plant to another?

Mr. ROSS. Yes, I think so. I would like to point out that there has been some highly relevant full-scale experience in the United States. In most PWR's the steam generator weighs more than the vessel. Steam generators have been removed and transported to disposal sites. In fact the NRC acquired one, I think, for a dollar, or some very low figure, from Virginia Power Co., and we used it at a research site. It was transported from eastern Virginia to the canal, up the western coast of the United States, and then inland to Hanford, where we have been operating it for several years.

We have to decommission it, at our expense, next year. At least two dozen boiling water reactors have replaced or are in the process of replacing all of their primary system piping. All this material is full scale. It has to be decontaminated and disposed of. So there has been a lot of full-scale relevant experience.

Mr. PACKARD. Does the uniqueness of each of the plants create a problem for the rulemaking?

Mr. ROSS. No.

Mr. PACKARD. How far along are we in our rulemaking process?

Mr. ROSS. Our schedule—we are in a comment evaluation period. Our schedule, to get to the punch line, shows the final rule October 1987. We are also preparing the final generic environmental impact statement, and all of this will come out at the same time. The rulemaking in this area has been very tedious because the

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[25] Mr. Voigt added "costs" after "decommissioning".

[26] Mr. Voigt changed "subject" to "cause".

[27] Mr. Voigt expanded this to read ". . . information like removing of valves, . . ."

NRC, in general, lacks financial expertise, and we have had to get a lot of help evaluating the large number of comments on the financial aspects.

Mr. PACKARD. The slowness of the rules in being released and finalized, has that been a delaying factor in terms of the setting up of funding plans and the collection of funds?

Mr. ROSS. I'd have to speculate. I don't really know, and the speculation is because it may be that a utility can't go to the PUC and get authority to divert money absent a firm regulatory requirement. To that extent it may be, but I just don't know.

Mr. PACKARD. In the initial stages of designing and building nuclear plants here in this country, at least, their cost estimates proved to be grossly low, in some cases 5 to 10 times higher costs ultimately resulted over their estimates. This was for a variety of reasons, of course; safety, environmental concerns, and a variety of other pressures that were placed on the development and building of the plants.

Do we expect the same, or could we expect the same kind of inaccuracies in terms of projecting the costs of decommissioning for some of the same reasons, or for a variety of other reasons that we may not even be aware of at this time.

Mr. VOIGT. I would be hopeful that we would not experience the same sort of growth in decontamination/decommissioning that we are seeing, because, as you pointed out, Congressman, there were a variety of reasons why that happened in a lot of plants. We are hopeful, in DOE, that with the new licensing reform package that we now have before Congress that a lot of the uncertainties that the utilities went through will be diminished in the future. So from that standpoint, the plant could be built in a shorter period of time, therefore not carrying all the interest costs on [28] construction. Again, that is my personal view.

Mr. ROSS. I think I agree, and I base it a lot on the full-scale experience previously cited.

Mr. PACKARD. Dr. Ross, what percentage of nuclear utilities have already submitted their decommissioning funding plans to the NRC.

Mr. ROSS. I'm not sure any have.

Mr. VOIGT. None.

Mr. PACKARD. When do you expect your first ones to start coming in?

Mr. ROSS. Well, I believe it says they have to 2 years after the final rule, so that would be between October 1987 and October 1989.

Mr. PACKARD. And all of them are required to submit their plans by that time, any plant that is now operating.

Mr. ROSS. That's correct.

Mr. PACKARD. Does that mean, then, that decommissioning of plants like the one at Humboldt Bay could not begin—now they are planning to put that in storage, but if they chose to move, they could not move in decommissioning until the rules are completed and until a funding plan is accepted and a variety of other things, perhaps, are done.

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[28] Mr. Voigt changed "on" to "during".

Mr. Ross. I understand the question. I would have to research the rule. I can't believe that we would have a rule that would preclude somebody from doing that when they are ready to do it. It would probably have to proceed on a case-by-case basis.

Mr. Packard. Mr. Voigt, how close to the west coast will the barges travel in the decommissioning of Shippingport? How close to the coastline of the country will it come, and will it be necessary to obtain approvals from the three States [California, Oregon, and Washington] along the west coast that could be impacted by travel of the barge?

Mr. Voigt. We definitely intend to clear with the three States on the movement of this barge. Now, I do not recall how far up [29] the coast the barge will be. It will be an ocean-going barge, so it could be beyond the so-called statutory [30] 3-mile limit, but this will be covered in our Safety Analysis Report, Congressman Packard, which we are in the process of developing, and we worked with [31] the Department of Transportation in getting approval to ship this barge through the Ohio River and the Mississippi River [32] and down through the Panama Canal and up the west coast, but I can't really say just how close it will be at this point.

Mr. Packard. Yesterday in the full committee we dealt with the repositories and some of the concerns there. Will the three States that are now considered for storage of the nuclear waste, will those resources be adequate to act as a repository for all of the needs of the decommissioning plants for the next, say, 20 years or so?

Mr. Voigt. I would break that down into just depending on the waste that comes as a result of the decontamination/decommissioning. I would expect the majority of the wastes to be low-level wastes which would be handled by commercial sites which are pursuant to the Low-Level Waste Policy Amendments Act passed last year.[33] That is the formulation of site compacts, low-level waste site compacts. There were seven ratified by Congress last year, seven specific compacts.

We look to the three existing commercial sites, as well as these additional sites, to handle all the low-level activities. Now, anything that is above low-level waste, for example greater than class C, but not high level, will be handled by the Department of Energy. That's another part of the Low-Level [34] Waste Policy Act that was passed, so that is the responsibility of the Government.

Mr. Packard. High level will go into the repository.

Mr. Voigt. Something less than high level, but greater than low level, would go into a Government-owned facility and low level would go to commercial sites.

Mr. Packard. How far along are we in identifying the sites for high, the intermediate and the low levels?

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[29] Mr. Voigt changed "up" to "off".

[30] Mr. Voigt requested deletion of the word "statutory".

[31] Mr. Voigt changed this to read ". . . the process of developing. We will work with . . ."

[32] Mr. Voigt changed this to read ". . . the Ohio and Mississippi Rivers . . ."

[33] Mr. Voigt changed this to read ". . . the Low-Level Radioactive Waste Policy Act, as amended last year."

[34] Mr. Voigt inserted the word "Radioactive".

Mr. VOIGT. Of course, the high[35] have been identified as the three sites[36] presently being considered. For greater than class C, we will be submitting our report to Congress by January 15 of next year to cover that disposal, and the low level, of course, Congress passed certain milestones that these[37] States have to meet, and they are in the process of developing and trying to meet these milestones.

Mr. PACKARD. Thank you, Mr. Chairman. I have no further questions.

Mr. VOLKMER. Now, let me ask Dr. Ross, we are assuming, and you both agreed that by the time we get ready to decommission the majority of these plants that we are going to have low-level waste sites available. But assume that we do not. You do approve in your rule a safe store type of operation pending availability of that type thing.

Mr. ROSS. Yes, that is one of the three cited options.

Mr. VOLKMER. One last question I have, and then we see if there is any from other members. Let's assume that one of these plants out there that is presently operating for some reason or other has to shut down a few years from now, 3 years from now, 4 years from now, 5 years from now. Let's assume that they have had a decommissioning funding mechanism in place for the 3 or 4 years. But now they are way short. What is NRC going to do?

Are you going to let them go to the State regulatory body and say, "We need more money?"

Mr. ROSS. Well, I don't think we have all that much to do with what they do at the State utility commission, but I assume from your description that they shut down, but it wasn't because they had a big accident.

Mr. VOLKMER. No accident, but let's assume that they determined for some reason or other they were going to shut it down.

Mr. ROSS. We have a survey[38] done, again, by Professor Siegel, of would the assets be sufficient to pay for it, and this consultant looked at four utilities, and he picked them quite carefully because, in his words, they were utilities that had got some of these later plants and they did have money problems. He concluded that there were enough assets in those four utilities to pay for decommissioning, and I think a fair reading of his report is that, even if the plant did not have enough opportunity to build up a fund, he would still have enough assets to pay for decommissioning.

I think it is a fairly readable report, and I could provide a copy to the subcommittees, if you would like to look at it.

At the hearing before the Subcommittee on Oversight and Investigations held on July 30, 1986 concerning the decommissioning of nuclear power plants, Dr. Ross of the NRC said he would provide a copy of the study made by Professor Siegel of the Wharton School wherein he concluded that there were enough assets to pay for decommissioning in the case of the plant shutdown before all decommissioning funds were accumulated. A copy of this study, "Utility Financial Stability and the Availability of Funds for Decommissioning," NUREG/CR-3899, is enclosed.

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[35] Mr. Voigt clarified this to read "high-level sites".

[36] Sites in Deaf Smith County, Texas; Yucca Mountain, Nevada; and Hanford, Washington are presently under consideration as the first high-level waste repository mandated by the Nuclear Waste Policy Act of 1982.

[37] Mr. Voigt requested deletion of the word "these".

[38] Mr. Ross changed "survey" to "study".

Mr. **Volkmer**. I would appreciate that, not for the record necessarily, but to committee staff so that staff could review it.

[The study was submitted and is retained in subcommittee files.]

Mr. **Volkmer**. At this time I would like to recognize the gentleman from New Mexico, the ranking minority member of the full committee, if he would like to ask any questions. I know he has been long vitally interested in the nuclear industry, and does the gentleman have any questions?

Mr. **Lujan**. Thank you, Mr. Chairman. Yes, I do have just a couple of quick questions. One, in reading the second page of your testimony that once the fuel was removed that all of it—everything that was left was low-level waste?

Mr. **Voigt**. That's correct, sir.

Mr. **Lujan**. Is that because they are not cutting it up, or if you cut it up would you have more high-level waste?

Mr. **Voigt**. No, even the pressure vessel itself, Mr. Lujan, is less than class C.

Mr. **Lujan**. Is that right?

Mr. **Voigt**. Yes, sir.

Mr. **Lujan**. So that makes it a lot simpler than many of us had imagined for decontamination.

Mr. **Voigt**. That's correct.

Mr. **Lujan**. Is the decontamination of Shippingport less or more of a job than you would have in decommissioning a commercial reactor?

Mr. **Voigt**. I would say about the same with one caveat. There was a very good decontamination of the facility prior to us taking it over, so, from that standpoint, the radiation levels throughout the system were extremely low, but I'd say that for a commercial plant, that can be done as well. Hence, the technology should be extrapolatable from ours to any size plant. It is the function of the size of pipe, the function of the size of pumps, steam generators, pressurizers, what have you.

Mr. **Lujan**. Thank you, Mr. Chairman.

Mr. **Volkmer**. The Chair recognizes the gentleman from Illinois.

Mr. **Fawell**. Thank you, Mr. Chairman.

I am sorry I did not hear your testimony, but is it correct to assume that all the activity which is now taking place in regard to rules and regs by the NRC is more or less triggered by the Shippingport situation? There is a gentleman shaking his head.

Mr. **Ross**. The genealogy really goes back almost 10 years ago. We had a number of petitions from public interest groups to take action on decommissioning for different reasons. I think that stimulated us to start our general rulemaking theory on the back end, but I think we probably would be where we are right now today with or without Shippingport. Shippingport is a useful data base, but I don't think it triggered the need for NRC to promulgate rules on decommissioning.

Mr. **Fawell**. What about the State agencies? I gather they have not been amortizing costs and putting them into rates so that all of those who are purchasing electricity from the commencement of the nuclear reactor operation, for instance, would be contributing toward the ultimate cost of decommissioning.

Mr. Ross. I think you are right, but in today's terms it is not that much anyway. If you had to spend $3 or $5 billion for a plant and another $130 million—not show up on your electric meter, it seems to be pretty small in a comparative sense. However, some plants only paid that for the whole plant. You bought a plant 15 years ago, $130 million would probably be all you paid for it.

Mr. Fawell. Are there any States that have or are now putting these costs in on a basis of when they would have to decommission?

Mr. Ross. I don't know. I would be glad to look into it and see if any State or States are doing that and supply it later. I don't know.

[The information follows:]

At the hearing before the Subcommittee on Oversight and Investigations held on July 30, 1986, concerning the decommissioning of nuclear power plants, Dr. Ross of the NRC said he would look into and supply to the Subcommittee information as to what States have utilities that are including decommissioning costs in the rate base. The latest information (February 1985) on this subject has been developed from a study made by the Edison Electric Institute titled, "Survey on Decommissioning Methods/Costs." The states are:

California; Colorado; Connecticut; Florida; Georgia; Illinois; Maryland; Massachusetts; Michigan; Minnesota.

New Jersey; New York; North Carolina; Ohio; Oregon; Pennsylvania; South Carolina; Virginia; and Wisconsin.

Mr. Packard. Would the gentleman yield for just a moment?

I am aware that California has imposed a requirement that they do collect as of the first of this year—the public utilities did implement that.

Mr. Fawell. Just one other question, Mr. Chairman.

When would you assume, considering that in this country we are not building nuclear power plants any longer—I'm not sure if that is going to be something that will continue or not, but do you have an estimate as when the bulk of our nuclear plants will be decommissioned and not operating?

Mr. Ross. If you assume that our last plant comes on line in the early 1990's, which I assume. I would assume that 50 years would be more like its lifetime than 40. Then we are talking about the year 2040, in that general facility, seeing the last of the plants as we now know them starting decommissioning.

Mr. Fawell. We trust that the long range R&D will supply us alternative sources of energy at that point.

Mr. Ross. Yes.

Mr. Fawell. Thank you.

Mr. Volkmer. Mr. Voigt, I understand that you have some VuGraphs or pictures of the oceangoing barge that you are going to use, and also the transportation passageway that you are going to use, et cetera.

Mr. Voigt. I do.

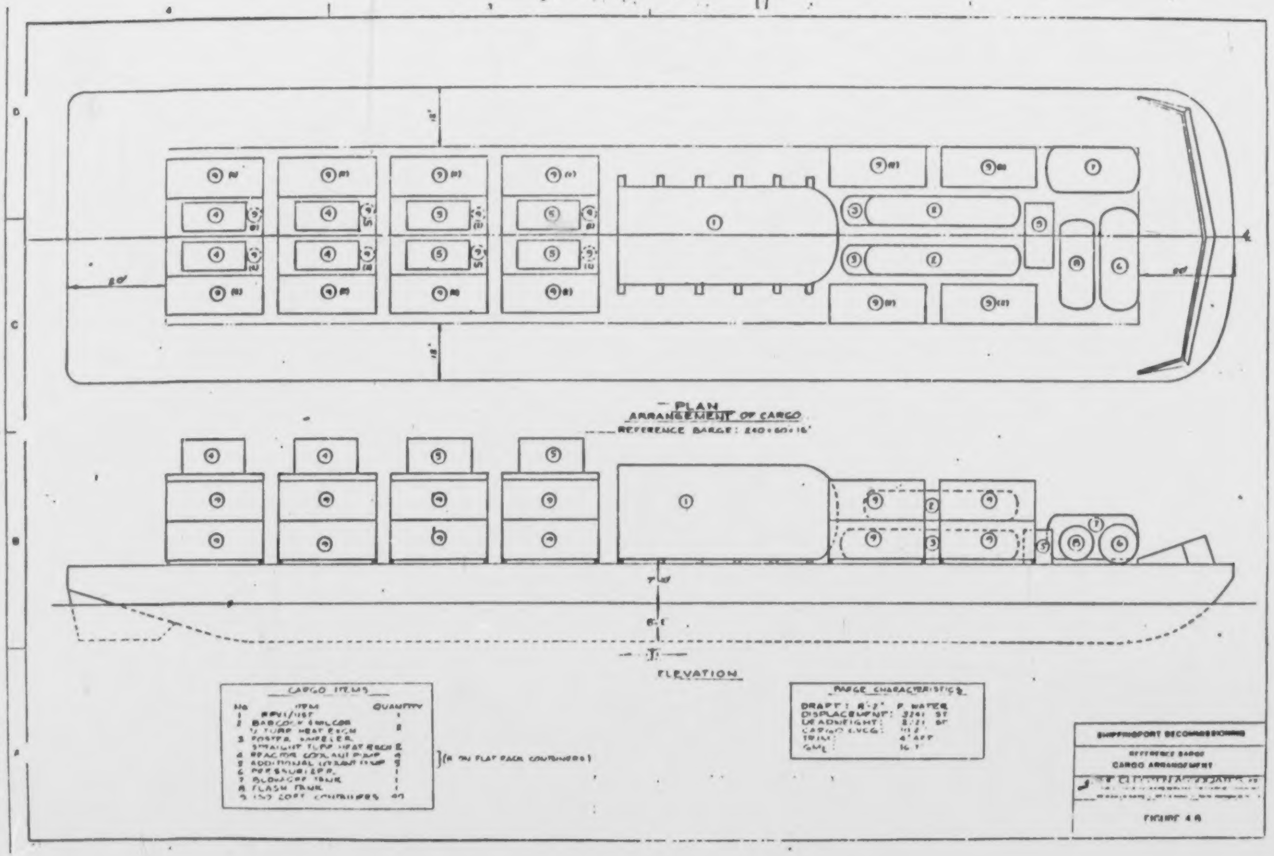
Mr. Volkmer. Would you submit that for the record? I don't necessarily have to see them now. I would like to have them for the record.

Mr. Voigt. I would be most happy to.

[The material follows:]

SSDP REFERENCE BARGE/CARGO ARRANGEMENT (DRAWING)

DRAFT


PLAN
ARRANGEMENT OF CARGO
REFERENCE BARGE: 240×60×16'
ELEVATION
CARGO ITEMS
NO ITEM QUANTITY
1 RPV/NST 1
2 BABCOCK & WILCOX U TUBE HEAT EXCH 2
3 FOSTER WHEELER STRAIGHT TUBE HEAT EXCH 2
4 REACTOR COOLANT PUMP 4
5 ADDITIONAL COOLANT PUMP 5
6 PRESSURIZER 1
7 BLOWOFF TANK 1
8 FLASH TANK 1
9 150 SOFT CONTAINERS 47
(ON FLAT RACK CONTAINERS)
BARGE CHARACTERISTICS
DRAFT: 8'-7" F. WATER
DISPLACEMENT: 3241 ST
DEADWEIGHT: 2121 ST
CARGO LVCG: 11.2'
TRIM: 4' AFT
GM_L: 16.1'
SHIPPINGPORT DECOMMISSIONING
REFERENCE BARGE
CARGO ARRANGEMENT
FIGURE 4.8

Mr. VOLKMER. And the other thing I wish to comment on that hasn't been—the gentleman from California touched on part of it on the ocean, and that is you are going to be going down to Ohio and Mississippi. You are going to be going through a lot of States. Will those States will be notified in advance of the timeframe when you will be going down the rivers?

Mr. VOIGT. You better believe it, sir.

Mr. VOLKMER. Plenty of time in advance?

Mr. VOIGT. Yes, sir.

Mr. VOLKMER. All right. I just wanted to make sure of that. There will be additional written questions for both of you, and we appreciate your replying back to the committee, and we will hold the record open until we get those, but we would like to have the replies as soon as possible to the written questions.

With that, unless the gentleman from California has any other questions, we will conclude this panel. I want to thank both of you very much.

Our next panel will be Mr. Frank Crimi and Mr. Lawrence Levy. Mr. Crimi is the manager for decommissioning services, General Electric Co. and site manager of Shippingport decommissioning project. Mr. Levy is Chairman of the Decommissioning Subcommittee of the Atomic Industrial Forum, and in that position has worked extensively with the Nuclear Regulatory Commission on the proposed rules for decommissioning.

Mr. Levy is accompanied this morning by Joseph Geruch, representing the Utility Decommissioning Group. Gentlemen, your prepared statements will be included in the record. You may either summarize them or read them in full, however you so desire. Mr. Crimi, you may begin.

STATEMENTS OF FRANK CRIMI, SHIPPINGPORT PROJECT MANAGER, GENERAL ELECTRIC CO., SHIPPINGPORT, PA; AND LAWRENCE LEVY, CHAIRMAN, SUBCOMMITTEE ON DECOMMISSIONING, ATOMIC INDUSTRIAL FORUM, BETHESDA, MD

Mr. CRIMI. Mr. Chairman, I am pleased to have this opportunity to testify on behalf of the General Electric Co. on the subject of the Shippingport station decommissioning project.

In 1983, when the Department of Energy announced its intention to secure proposals for the decommissioning operations contractor, which we are called, the General Electric [39] immediately assigned resources toward this [40] project. General Electric has a strong interest in decommissioning work because of the significance of this technology to the nuclear industry. The significance relates to both the safe accomplishment of future decommissionings and to the ramifications that decommissioning cost effectiveness will have on the future growth of the nuclear industry.

General Electric has been a key contributor to the technology and growth of the [41] industry since its inception. Our involvement includes the full spectrum of research, development, construction, operation, maintenance, and services. We have played a major role in the development of commercial nuclear power plants, naval nuclear reactors, research reactors, and space reactors. General Electric drew upon this diverse experience and assembled a team of highly qualified personnel to staff the Shippingport station decommissioning project. My nine-man staff and myself represent 198 man-years of relevant nuclear experience.

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[39] Mr. Crimi inserted the word "Company".

[40] Mr. Crimi inserted the word "important".

[41] Mr. Crimi inserted the word "nuclear".

I'd like to start out by explaining the role of the decommissioning operations contractor. I will then provide information on the specific subject areas which you asked me to address in your letter on July 15.

The decommissioning operations contractor [DOC] is responsible for the following areas: We manage the total decommissioning operation. We perform engineering to convert the decommissioning plan activity specifications into technical specifications for subcontracting the work to U.S. industrial firms. We procure supplies and subcontractor services. We manage and administer Government property. We supervise waste management and transportation. We are responsible for protecting the health and safety of all personnel working on the project; protecting the environment and the public; performing systems operations and some limited decommissioning work with the DOC workforce, and we gather data for technology transfer to the nuclear industry, and assist DOE and their technical support contractor in the dissemination of technology transfer information.

Now to accomplish this responsibility, GE preselected Morrison-Knudsen as its integrated subcontractor. The remainder of my discussion covers the following subject areas: the current status of the project, technology being utilized, technology transfer, waste management and transportation, and protection of the workers and the environment.

Current status: The Shippingport station decommissioning project is on schedule. Operational responsibility for the station was transferred from Duquesne Light Co. to General Electric in September 1984.[42] The removal of insulation from piping and components began in August 1985. This was followed by the removal of the first radioactive primary plant components in September 1985. Today, most of the insulation has been safely removed from the facility and the removal of piping and components is continuing.

Early in the project a total of 99 milestones were established, against which cost and performance are measured on a monthly basis. As of July 23, 1986, 30 milestones were due to have been completed, of which 28 are now complete. The two remaining milestones, which are [43] scheduled to be completed in August 1986, are related to insulation removal and are not on the critical path. The project is currently underrunning the cost budget established in 1985 by $600,000.

Technology being utilized: The technology we are utilizing is really the technology that has been developed as a result of having to maintain and modify the operating nuclear plants over the past 30 years. The technology includes: methods for dismantling radioactive piping systems and components, dismantling radioactive structures, decontamination of equipment and structures, processing radioactive fluids, solidifying radioactive sludge and resin, removal and disposal of asbestos insulation, packaging and transportation of radioactive waste and heavy lifting and hauling operations.

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[42] Mr. Crimi changed this to read, ". . . General Electric on September 6, 1984".

[43] Mr. Crimi inserted the word "now".

Existing methods provide adequate industrial and environmental safety, and with proper management can be implemented consistent with the requirement to maintain personnel radiation exposure as low as reasonably possible.[44] Personnel radiation exposures have been maintained well below the exposure budget established for the project early in 1985. This has been accomplished through management attention and innovative techniques.

There is virtually no aspect of the decommissioning process that requires the development of new or unique technology. For Shippingport, the selection of the specific technology to be applied is left to potential subcontractors within boundaries established by the DOC. To help keep cost under control, all subcontracts to date have been competitively bid, fixed-price contracts. The technical specifications for the fixed price subcontracts define appropriate performance requirements and applicable safety regulations; that is, we define what is tc be done, not how it is to be done. This approach allows prospective subcontractors to apply either existing technologies or innovative methods to meet the requirements in a safe and cost-effective manner.

I'll talk about technology transfer. The overall responsibility for the technology transfer rests with the Department of Energy. The technical support contractor, UNC Nuclear Industries, provides direct on-site support to DOE in the technical and administrative areas, including technology transfer. We are responsible for collecting and transferring the information to DOE such as cost and schedule data, man-hours, radiation exposure, waste volumes, radioactive content, methods employed, lessons learned and recommendations.

This raw data is obtained from the DOC records, including inputs from the subcontractors. The DOC also provides assistance to DOE for on-site visitors, and we also participate in selected professional society meetings, decommissioning seminars and conferences.

The Shippingport Station decommissioning project has established policies and written procedures for the transfer of Shippingport technology to domestic utilities, professional and educational institutions, U.S. industry, U.S. Government agencies, and other countries participating in a decommissioning technology program with the United States. The information will be disseminated via the following: reports, presentations, or industry participation in the form of loaned employees. Mr. Voigt has given you some of the details of the program.

I would like to talk about waste management and transportation, and I will cover regulations, waste management activities, and the cost of waste management and transportation. With regard to regulations, the intent of the Shippingport Station decommissioning project for handling, packaging, and transporting of hazardous and radioactive materials is to comply with all applicable Federal regulatory requirements.

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[44] Mr. Crimi changed "possible" to "achieveable."

This includes the Code of Federal Regulations, title 40, Protection of the Environment, and title 49, Transportation, as well as applicable DOE orders which amplify the Federal regulations. Practices employed in packaging, handling and transporting the wastes are consistent with the practices utilized throughout the commercial nuclear industry.

The burial portion of the waste cycle is being performed by DOE and their contractor, Rockwell Hanford Operations, in accordance with DOE orders for the Hanford facility.

Waste management activities: The project's overall planning for waste management activities is described in a waste management plan prepared by General Electric and approved by the Department of Energy. The plan is implemented by detailed project instructions and manuals. As waste is generated, it is radiologically surveyed to establish the proper waste classification. After classification, the waste is packaged to meet DOE burial ground criteria using Department of Transportation approved shipping containers. The majority of the waste is packaged in low specific activity containers. These are the same ones being utilized by the commercial nuclear industry today.

The shipment of the reactor pressure vessel will be carried out in accordance with Department of Transportation regulations. It should be noted, as was mentioned by Dr. Ross, a comparable shipment had been made previously; the 1980 shipment of the Surrey Nuclear Power Plant steam generator.

It is planned to transport the larger components—the reactor pressure vessel, pressurizer, steam generators—and other radioactive materials, on an ocean-going barge. The barge route will be down the Ohio River and the Mississippi River into the Gulf of Mexico, through the Panama Canal and up the west coast to the Columbia River, then to the Port of Benton, WA. At Benton the radioactive material will be off-loaded and transported by land vehicles to the DOE burial ground at Hanford. Details of the barge transportation plan are currently being developed. The agencies which require notification along the route of shipment in addition to the States are the Coast Guard, Panama Canal authority and captains of the Ports at New Orleans; Portland, OR; and Benton, WA.

DOE is responsible for all interactions with the States. For low specific activity truck shipments, no notification of agencies along the route is required. A list of States through which truck shipments are made include Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, Wyoming, Utah, Idaho, Oregon, and Washington.

Let's talk about the cost of waste management and transportation. The project is following practices which are consistent with the commercial nuclear industry; that is, the cost of packaging and transportation portions of the waste cycle are comparable to what would be experienced in the commercial industry for the waste being handled. Shippingport waste burial costs are substantially less than commercial burial costs, because the waste is being buried at the Government operated facility at Hanford. Waste burial costs are not included in the General Electric contract.

I would like to address the subject of protecting the health and safety of the on-site workers and protecting the environment and the public. I will cover regulations, practices and results to date.

In addition to the Federal regulations which I previously discussed under waste management and transportation, the project operates under applicable Federal regulations for the protection of personnel health and safety; that is, 10 CFR 20, Standards for Radiation Protection. Through adherence with DOE orders, we operate under requirements which are comparable to the OSHA [Occupational Safety and Health Administration] standards.

Protection of the environment is established by compliance with Federal regulations and those of the State of Pennsylvania. The project operates in accordance with a permit issued by the Pennsylvania Department of Environmental Resources as part of the National Pollutant Discharge Elimination System.

The DOE orders for protecting the worker and the environment are implemented through project instructions and manuals such as the Project Safety Manual and the Project Radiological Controls Manual. The practices, policies, and regulations being applied to the Shippingport project will be part of the Technology Transfer Program.

Practices: Our practice in assuring protection of workers and the environment includes drawing upon the General Electric and Morrison-Knudsen corporate resources to augment our on-site personnel by providing technical expertise and management focus in this key area. Some examples of corporate contributions include recent implementation of the Hazardous Communications Act via an employee training program developed by GE corporate safety personnel.

Another includes senior management personnel from both GE and MK participating on our Independent Safety Review and Analysis Committee. That committee does a periodic on-site review of the project to assure that the GE and Morrison Knudsen corporate standards of excellence are maintained.

Another key element of our practices is a strong commitment of all onsite project personnel to achieving an excellent record in the area of personnel and environmental safety. I personally chair a management safety committee which meets regularly to review safety matters and provide overall direction. We have a strong management commitment to the maintenance of radiation exposure levels as low as reasonably achievable. The Management Safety Committee reviews the project's cumulative personnel radiation exposure and the details of selected radiological procedures to assure that an effective ALARA program is being achieved.

At the individual worker level we place heavy emphasis on the worker understanding both the assigned task and the proper safety practices. Some methods used to accomplish this are extensive use of written detailed procedures, specialized training programs, safety meetings, mock-up training, safety newsletters and regular discussions of lessons learned.

Our [45] Results to Date: Routine monitoring of the environment has shown that all operations have met Federal and State requirements. The project has had no adverse impact on the environment. Our industrial safety record thus far is comparable to the demolition industry. With regard to the concerns associated with asbestos and radiological work, we have been successful in assuring that worker health has been protected.

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[45] Mr. Crimi requested deletion of the word "our".

Radiation exposure is currently being maintained significantly below the engineering estimate for the work performed thus far. In like manner, asbestos exposures have uniformly been well within the standards recently set by the EPA International Asbestos Council.

In conclusion, we plan to continue the close attention to the details of managing the project. This now concludes my planned statement.

[The prepared statement of Mr. Crimi follows:]

STATEMENT OF
FRANK P. CRIMI
General Electric Company
Nuclear Energy Business Operations
before the
House Committee on Science and Technology
Subcommittee on Investigations and Oversight
Subcommittee on Energy Research and Production

July 30, 1986

Mr. Chairman, I am pleased to have this opportunity to testify on behalf of the General Electric Company on the subject of the Shippingport Station Decommissioning Project (SSDP).

In 1983, the Department of Energy (DOE) announced its intention to secure proposals for the Decommissioning Operations Contractor (DOC) for the Shippingport Project. The General Electric Company immediately assigned resources toward this important project. General Electric has a strong interest in decommissioning work because of the significance of this technology to the nuclear industry. The significance relates to both the safe accomplishment of future decommissioning projects and to the ramifications that decommissioning cost effectiveness will have on the future growth of the nuclear industry.

General Electric has been a key contributor to the technology and growth of the nuclear industry since its inception. Our involvement includes the full spectrum of research, development, construction, operation, maintenance, and services. We have played a major role in the development of commercial nuclear power plants, naval nuclear reactors, research reactors and space reactors. General Electric drew upon this diverse experience and assembled a team of highly qualified personnel to staff the Shippingport Station Decommissioning Project. My nine-man staff and myself represent 198 man-years of relevant nuclear experience.

I'd like to start out by explaining the role of the Decommissioning Operations Contractor. I will then provide information on the specific subject areas which you asked me to address in your letter of July 15, 1986.

The Decommissioning Operations Contractor is responsible for the following areas:

- Managing the total Decommissioning Operations
- Performing engineering to convert the Decommissioning Plan Activity Specifications into Technical Specifications for subcontracting the work to U.S. industrial firms
- Procuring supplies and subcontractor services
- Managing and administering government property
- Supervising Waste Management and Transportation
- Protecting the health and safety of all personnel working on the Project
- Protecting the environment and the public
- Performing systems operations and some limited decommissioning work with the DOC work force

- Gathering data for technology transfer to the nuclear industry
- Assisting DOE and their Technical Support Contractor in the dissemination of technology transfer information.

To accomplish this responsibility, GE pre-selected Morrison Knudsen-Ferguson (MK-Ferguson) as its integrated subcontractor. The remainder of my discussion covers the following subject areas:

- Current Status of the Shippingport Decommissioning Activities
- Technology Being Utilized
- Technology Transfer
- Waste Management and Transportation
- Protection of Workers and the Environment.

CURRENT STATUS

The Shippingport Station Decommissioning Project is on schedule. Operational responsibility for the Shippingport Atomic Power Station was transferred from Duquesne Light Company to General Electric on September 6, 1984. The removal of insulation from piping and components began in August 1985. This was followed by the removal of the first radioactive primary plant components in September 1985. Today, most of the insulation has been safely removed from the facility and the removal of piping and components is continuing.

Early in the Project, a total of 99 milestones were established, against which cost and performance are measured on a monthly basis. As of July 23, 1986, 30 milestones were due to have been completed, of which 28 are now complete. The two remaining milestones, which are now scheduled to be completed in August 1986, are related to insulation removal and are not on the critical path.

The Project is currently underrunning the cost budget established in 1985 by $600,000.

TECHNOLOGY BEING UTILIZED

Maintenance and modification techniques currently used by operating nuclear plants is the technology being used to decommission the Shippingport Atomic Power Station.

This technology includes methods for:

- Dismantling radioactive piping systems and components
- Dismantling radioactive structures
- Decontamination of equipment and structures
- Processing radioactive fluids
- Solidifying radioactive sludge and resin
- Removal and disposal of asbestos insulation
- Packaging and transportation of radioactive waste
- Heavy lifting and hauling operations.

Existing methods provide adequate industrial and environmental safety, and, with proper management, can be implemented consistent with the requirement to maintain personnel radiation exposure As Low As Reasonably Achievable (ALARA).

Personnel radiation exposures have been maintained well below the exposure budget established for the Project early in 1985. This has been accomplished through management attention and innovative techniques.

There is virtually no aspect of the decommissioning process that requires the development of new or unique technology. For Shippingport, the selection of the specific technology to be applied is left to potential subcontractors within boundaries established by the DOC. To help keep cost under control, all subcontracts to date have been competitively bid, fixed-price contracts. The technical specifications for the fixed price subcontracts define appropriate performance requirements and applicable safety regulations. That is, we define what is to be done, not how it is to be done. This approach allows prospective subcontractors to apply either existing technologies or innovative methods to meet the requirements in a safe and cost-effective manner.

TECHNOLOGY TRANSFER

Overall responsibility for the Technology Transfer Program rests with the Department of Energy. A Technical Support Contractor (TSC), UNC-Nuclear Industries, provides direct on-site support to DOE in the technical and administrative areas, including technology transfer. The DOC is responsible for collection and transfer to DOE of specific information, such as cost and schedule data, manhours, radiation exposure, waste volume and radioactive content, methods employed, lessons learned, and recommendations. This raw data is obtained from the DOC records, including inputs from the subcontractors. The DOC also provides assistance to DOE for on-site visitors. With DOE approval, the DOC participates in selected professional society meetings, decommissioning seminars and conferences.

The Shippingport Station Decommissioning Project has established policies and written procedures for the transfer of Shippingport technology to domestic utilities, professional and educational institutions, U.S. industry, U.S. government agencies, and other countries participating in a decommissioning technology transfer program with the United States. The information will be disseminated via the following mechanisms:

- Reports
- Presentations
- Industry participation in the form of loaned employees

The details of this program have been presented to you by Mr. Voigt.

WASTE MANAGEMENT AND TRANSPORTATION

Now I want to address the subject of waste management and transportation. I will cover the following topics:

- Regulations
- Waste Management Activities
- Cost of Waste Management and Transportation

Regulations

The intent of the Shippingport Station Decommissioning Project for handling, packaging and transporting of hazardous and radioactive materials is to comply with all applicable federal regulatory requirements. This includes the "Code of Federal Regulations", Title 40 - "Protection of Environment" and Title 49 - "Transportation", as well as applicable DOE Orders which amplify the federal regulations. The practices employed in packaging, handling and transporting the waste are consistent with the practices utilized throughout the commercial nuclear industry.

The burial portion of the waste cycle is being performed by DOE and their contractor, Rockwell Hanford Operations, in accordance with the DOE orders for the Hanford facility.

Waste Management Activities

The Project's overall planning for waste management activities is described in the Waste Management Plan prepared by General Electric and approved by DOE. The plan is implemented by detailed Project Instructions and Manuals.

As waste is generated, it is radiologically surveyed to establish the proper waste classification. After classification, the waste is packaged to meet DOE burial ground criteria using Department of Transportation (DOT) approved shipping containers. The majority of the waste is being packaged in Low Specific Activity containers. These are the same as those utilized by the commercial nuclear industry.

The shipment of the reactor pressure vessel will be carried out in accordance with DOT regulations. It should be noted that a comparable shipment has been made previously; the 1980 shipment of the Surrey Nuclear Power Plant steam generator.

It is planned to transport the larger components -- reactor pressure vessel, pressurizer, steam generators and other radioactive materials on an ocean barge. The barge route will be down the Ohio River and the Mississippi River to the Gulf of Mexico, through the Panama Canal, and up the West Coast to the Columbia River, then to the Port of Benton, Washington. At Benton, the radioactive material will be off-loaded and transported by truck to the DOE burial ground at Hanford, Washington. Details of the barge transportation plan are currently being developed. The agencies which require notification along the route of shipment are: the Coast Guard, Panama Canal authorities, Captains of the Ports at New Orleans, Louisiana, Portland, Oregon and Benton, Washington.

DOE is responsible for all interactions with the states. For truck shipments, no notification of agencies along the route is required. The list of states through which truck shipments are made include Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, Wyoming, Utah, Idaho, Oregon, and Washington.

Cost of Waste Management and Transportation

The Project is following practices which are consistent with the commercial nuclear industry. That is, the cost of the packaging and transportation portions of the waste cycle are comparable to what would be experienced in the commercial industry for the waste being handled. Shippingport's waste burial costs are substantially less than commercial burial costs because the waste is being buried at the government operated facility at Hanford. Waste burial costs are not included in the General Electric contract.

PROTECTION OF WORKERS AND THE ENVIRONMENT

Now I'd like to address the subject of protecting the health and safety of the on-site workers and protecting the environment and the public. I will cover the following topics:

Regulations
Practices
Results to Date

Regulations

In addition to the Federal regulations which I previously discussed under waste management and transportation, the Project operates under applicable federal regulations for the protection of personnel health and safety (e.g., 10CFR20 - "Standards for Radiation Protection"). Through adherence with DOE orders, we operate under requirements which are comparable to the OSHA standards.

Protection of the environment is established by compliance with federal regulations and those of the State of Pennsylvania. The Project operates in accordance with a permit issued by the Pennsylvania Department of Environmental Resources as part of the National Pollutant Discharge Elimination System.

The DOE orders for protecting the worker and the environment are implemented through Project Instructions and manuals such as the Project Safety Manual and the Project Radiological Controls Manual. The practices, policies, and regulations being applied to the Shippingport Project will be part of the Technology Transfer Program.

Practices

Our practice in assuring protection of workers and the environment includes drawing upon the General Electric and MK-Ferguson corporate resources to augment our on-site personnel by providing technical expertise and management focus in this key area. Some examples of corporate contributions include the following:

- Recent implementation of the the Hazardous Communications Act via an employee training program developed by GE corporate safety personnel.
- Senior management personnel from both GE and MK-Ferguson participating on our Independent Safety Review and Analysis Committee. That committee does a periodic on-site review of the Project to assure that the GE and MK-Ferguson corporate standards of excellence are being achieved.

Another key element of our practices is a strong commitment of all on-site Project personnel to achieving an excellent record in the area of personnel and environmental safety. I personally chair a Management Safety Committee which meets regularly to review safety matters and provide overall direction. We have a strong management commitment to the maintenance of radiation exposure levels as low as reasonably achievable (ALARA). The Management Safety Committee reviews the Project's cumulative personnel radiation exposure and the details of selected radiological procedures to assure that an effective ALARA program is being achieved.

At the individual worker level we place heavy emphasis on the worker understanding both the assigned task and the proper safety practices. Some methods used to accomplish this are: written detailed procedures, specialized training programs, safety meetings, mock-up training, safety newsletters, and regular discussion of lessons learned.

Results To Date

Routine monitoring of the environment has shown that all operations have met Federal and State requirements. The Project has had no adverse impact on the environment.

Our industrial safety record thus far is comparable to the demolition industry. With regard to the concerns associated with asbestos and radiological work, we have been successful in assuring that worker health has been protected. Radiation exposure is currently being maintained significantly below the engineering estimate for the work performed thus far. In like manner, asbestos exposures have uniformly been well within the standards recently set by EPA and the National Asbestos Council.

CONCLUSION

In conclusion, General Electric plans to continue to provide the necessary management attention required to maintain the Project's excellent performance record.

Mr. **Volkmer**. Thank you very much, Mr. Crimi. Mr. Levy.

Dr. **Levy**. Good morning, ladies and gentleman. My name is Lawrence Levy and I am an engineer from Northeast Utilities in Connecticut. I am the chairman of the Atomic Industrial Forum [AIF] Subcommittee on Decommissioning, and I am submitting these comments on behalf of the AIF and the Edison Electric Institute [EEI].

With me to my left is Mr. Joseph Geruch. He is the manager of technical accounting at Northeast Utilities, and he will be available after my presentation to answer any questions regarding the financial aspects of decommissioning. We both appreciate the opportunity to provide you with an industry perspective regarding the financial and technical needs of the utility industry relative to decommissioning.

As background for my presentation, I would like to note briefly the involvement that AIF and EEI both had with decommissioning. Since 1976, when AIF produced the generic decommissioning cost study in 1986, to the development of guidelines producing site specific nuclear plant decommissioning cost estimates. I have a copy of these studies with me today, and I will be glad to leave them with the committee after my presentation.

Some of the major issues that I would like to speak to this morning go into the presumption that nothing is more important to utilities right now than to collect the proper amount for decommissioning from rate payers. Since most of the plants in the large megawatt class are going to be decommissioned within the first and second decade of the next century, we need to collect the proper amounts for decommissioning, and most of my comments circulate around that thought.

The first item I would like to discuss is that from a technical and financial standpoint, the current NRC regulations as contained in 10 CFR 50 are fully adequate for termination of a power reactor license. The current NRC approach of a case-by-case basis allows the flexibility that is needed for an activity that will not occur for many years. We need that flexibility, because many utilities don't know at this time exactly whether they are going to use complete dismantlement, mothballing or entombment; and we agree with Dr. Ross, as he mentioned before, that we don't consider an indefinite entombment or an indefinite mothballing as a proper alternative.

We agree that you should have a set limit, 30, 50, or 100 years, as the appropriate time for mothballing or entombment. From a financial perspective, I want to emphasize that it is our understanding that the NRC's and the utilities' objective in this area is to achieve a reasonable assurance that decommissioning funds will be available to NRC licensees when needed. The comprehensive rate and financial and regulatory process to which electric utilities are subject advise that reasonable assurance without the need for a new NRC rule.

The second point, as was brought up earlier, was on decommissioning costs. Questions in the past regarding the ability of nuclear utilities to develop accurate estimates of the cost of decommissioning prompted the NRC to contract with Battelle Pacific Northwest Laboratories for generic decommissioning cost estimates. These would go into 1978 and 1980. However, in the past 8 years or so, costs have increased tremendously. In fact, due to inflation, labor rates and especially radioactive waste burial costs, which have gone up well over 1,000 percent in these 8 years, costs have increased four to five times the Battelle decommissioning estimate.

Today, nuclear utilities are developing site-specific cost estimates which is much more advantageous over generic studies. Some of the cost estimates and the numbers that you have seen and heard of in the past, the variation can be explained by certain items: Regional variation and labor rates, amount of reinforcing and seismic structures, the type of plant, the physical size of the plant and the assumptions regarding plant operation history.

As mentioned earlier, the AIF has recently completed a project to develop guidelines for producing site specific cost estimates. Use of these guidelines, which I have here, which I will be leaving with the committee,[46] will be able to achieve consistent cost estimates among the various plants, easily facilitate periodic updates and support the NRC's and industry's objective of assuring that adequate funds are available for decommissioning in nuclear plants.

These were developed through a task force consisting of utilities, consultants, architect engineers, nuclear steam supply system vendors and liaisons from the NRC, National Association of Regulatory Utility Commissioners, FERC [Federal Energy Regulatory Commission], and representatives from three State public utility commissions. One of the objectives of these guidelines was to provide a reliable and widely recognized reference tool which will eliminate the need to refer to generic estimates.

The FERC in the past, and I know through personal experience in testifying, has used generic studies instead of site specific studies, and it is important that we get more toward the site specific rather than the generic. On the proposed NRC rule on decommissioning—on February 1985, the NRC published in the Federal Register for public comment the proposed rule to provide decommissioning criteria for nuclear facilities.

Overall, the AIF subcommittee and EEI compliment the NRC for the thorough job they have done in drafting this proposed rule, after extensive research in gathering background information. A number of the key issues which have been adequately addressed in the proposed rule is the permitted use of the internal reserve funding mechanism for utilities. I'm glad that the NRC recognizes that internal reserve method provides sufficient assurance of funds at the time of decommissioning.

We also strongly endorse the NRC's statement that decommissioning can be accomplished safely at a reasonable cost shortly after final reactor shutdown. As we heard from Congress this morning, the Shippingport reactor is going—the project is going strongly. However, there is one deficiency that I would like to talk to that was addressed briefly by one of the Congressmen earlier, and that is concerning the $100 million certification amount.

The proposed rule—in 10 CFR, part 50—licensees submit either a site-specific decommissioning funding plan or a certification that financial assurance for decommissioning be provided in amounts equal to $100 million. The NRC's objective for including this type of provision in the rule is to assure that adequate funds are available for decommissioning.

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[46] The material referred to by Dr. Levy, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," was submitted and is retained in subcommittee files.

The NRC—and this is where we strongly object—has concluded that the $100 million is sufficient to cover decommissioning costs for most power reactors. This is simply not true. In the 1,150 megawatt class, which is a large type of reactor, costs are well above the $100 million mark. In fact, almost all studies today done by consultants or utilities, they are more in the range of $180 million to $220 million, and the problem with stating the $100 million mark is that public utility commissions and the FERC will use that $100 million as a ceiling for utilities to recover decommissioning costs.

There have been several rate cases already, even though it is only in the proposed rule making, they point to the $100 million mark and saying, "Well, that is the minimum amount. If that is good for the NRC, it is good for the State public utility commissions." This is really hurting the utility industry a lot, because we are not collecting the proper amount that we are supposed to, and that is a very important point to remember in your regulations in the future.

In summary, the principal deficiency of the proposed rule is the conclusion that $100 million will provide sufficient funds to cover the costs of decommissioning most power reactors. The practical effect, as I just mentioned, is that it will provide a ceiling in rate cases, and this is plainly contrary to the NRC's objective of assuring adequate decommissioning funding.

If we can put the decommissioning costs into context, although in absolute terms the cost of decommissioning is substantial—$100 million to $200 million, in relative terms—the cost of decommissioning is not large when compared to other costs the electric utilities have. If I might use my own company, Northeast Utility, as an example, the cost of decommissioning Millstone Unit 2, at a cost of $145 million, would represent less than 7 percent of our current annual revenues and less than 22 percent of our 1985 construction program.

Let me turn briefly to the issue of funding. Basically there are two decommissioning funding methods: External, where funds are invested in marketable securities; and internal, where funds are invested in new assets of the utility. The external funding method is two to three times more expensive than the internal method. The internal reserve funding method is the one that is presently in place for most utilities.

With the internal funding method, the estimated cost of decommissioning is incorporated into the depreciation expense the company recovers through rates. This provides for recovery of decommissioning costs over the life of the plant. The NRC proposed decommissioning rule probably recognized the internal reserve method and it provides reasonable funding of assurance and is appropriate for most utilities.

I should also note that the NRC consultant, Professor Siegel, as we heard earlier, from the Wharton School of Finance, has concluded that the internal reserve meets the NRC's reasonable assurance standard, and Professor Siegel concluded that the internal reserve provides excellent assurance of the availability of funds for decommissioning.

The standard that governs the NRC's evaluation of alternative funding methods is reasonable assurance, and the choice between alternative funding methods meeting that standard is for State and Federal rate regulators to make because the internal funding method provides reasonable funding assurance, is appropriate for use by utility licensees.

That concludes my remarks on the financial and technical needs of the utility industry relative to decommissioning. On behalf of the Atomic Industrial Forum and the Edison Electric Institute, I want to thank the committee for your patience and attention this morning. I would like to offer the assistance of our committee to your committee on issues related to decommissioning, and I will be glad to answer any questions you have at this time.

[The prepared statement of Dr. Levy follows:]

PRESENTATION OF LAWRENCE H. LEVY
NORTHEAST UTILITIES
FOR THE ATOMIC INDUSTRIAL FORUM
SUBCOMMITTEE ON DECOMMISSIONING
AND THE EDISON ELECTRIC INSTITUTE
ON THE NEEDS OF THE UTILITY INDUSTRY
RELATIVE TO DECOMMISSIONING

TO BE PRESENTED BEFORE THE SUBCOMMITTEE
ON ENERGY RESEARCH AND PRODUCTION
AND THE SUBCOMMITTEE ON INVESTIGATIONS AND
OVERSIGHT OF THE U.S. HOUSE OF REPRESENTATIVES COMMITTEE
ON SCIENCE AND TECHNOLOGY ON JULY 30, 1986

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THE NEEDS OF THE UTILITY INDUSTRY RELATIVE TO DECOMMISSIONING

BY LAWRENCE LEVY FOR THE AIF SUBCOMMITTEE ON
DECOMMISSIONING AND THE EDISON ELECTRIC INSTITUTE
WASHINGTON, D.C.
JULY 30, 1986

A. Introduction and Background

Good morning ladies and gentlemen. My name is Lawrence Levy and I am an engineer for Northeast Utilities. I'm Chairman of the Atomic Industrial Forum's (AIF) Subcommittee on Decommissioning and I submit these comments on behalf of that subcommittee and the Edison Electric Institute (EEI).

With me is Mr. Joseph Geruch, Manager of Technical Accounting at Northeast Utilities and a member of the Utility Decommissioning Group (UDG). The UDG consists of 13 power reactor licensees and the Edison Electric Institute and is concerned mainly with financial issues affecting nuclear power plant decommissioning. He will be available after my presentation to answer questions regarding the financial aspects of decommissioning.

We appreciate the opportunity to provide you with an industry perspective regarding the financial and technical needs of the utility industry relative to decommissioning. The remarks I am making today are derived from the AIF and UDG comments submitted to the NRC regarding that agency's proposed decommissioning rule.

As background for this presentation, I would like to note briefly the long involvement that AIF and EEI both have with decommissioning. This includes various studies, analyses, and NRC presentations, etc., since 1976. A sample of some of the major studies sponsored by the AIF are listed as References 4-7.

I would like to mention two recent AIF decommissioning-related studies (prepared by the AIF's technical research program, the National Environmental Studies Project (NESP)) that may be of particular interest to the subcommittees. One study is a preliminary assessment of the potential worker and public radiation dose savings associated with "intact decommissioning", a possible decommissioning alternative using the reactor containment as a permanent storage facility. The other study, as will be discussed later, was also just completed and develops guidelines to assist those making nuclear power plant decommissioning cost estimates to achieve more accurate and consistent estimates.

B. Major Issues

I would now like to discuss the major issues which the utility industry believes to be important considerations in the development of decommissioning regulations.

1. No Need for Detailed NRC Regulation

From a technical and financial standpoint, the current Nuclear Regulatory Commission (NRC) regulations as contained in 10CFR 50 are fully adequate for terminating a power reactor license. We wish to reaffirm our belief that new regulations are not required in this area. The current NRC approach of a case-by-case review allows the flexibility that is needed for an activity that will not occur for many years, when new techniques may be available and utilities and regulators will have decided on the future use of nuclear plant sites. In addition, differing local requirements of state public service commissions, municipalities, and other government agencies support the need for maintaining flexibility in decommissioning planning and in the NRC's regulation of decommissioning. For example, complete dismantlement of the power reactor facility may not necessarily be the optimum decommissioning mode in all cases. A flexible approach may have significant advantages from an environmental impact and cost standpoint. Accordingly, we emphasize the desirability of maintaining flexibility in any regulatory requirements on decommissioning.

From a financial perspective, I want to emphasize that it is our understanding that the NRC's objective in this area is to achieve reasonable assurance that decommissioning funds will be available to NRC licensees when needed. Traditionally, the NRC has used the standard of "reasonable assurance" in its financial qualification reviews as well as for other public health and safety issues. The NRC Staff's report on decommissioning financing, NUREG-0584, recommends this same standard be applicable to establishing the proper degree of assurance for funding decommissioning. The comprehensive rate and financial regulatory process to which electric utilities are subject provides that reasonable assurance, without the need for a new NRC rule.

2. Decommissioning Costs

A second important issue is the matter of decommissioning costs. Questions raised in the past regarding the ability of the nuclear utilities to develop accurate estimates of the cost of decommissioning a nuclear power plant prompted the NRC to contract with Battelle Pacific Northwest Laboratory for generic decommissioning cost estimates. Although the Battelle studies, published in 1978 and 1980, provided a needed benchmark for decommissioning costs, recent increases in costs due to labor, materials and, especially, radwaste shipping and burial have caused industry estimates to rapidly escalate four-to-five times the 1978 Battelle estimates.

Nuclear utilities are developing individual site specific cost studies, as demonstrated by the results of a 1985 survey by the Edison Electric Institute (EEI) of 30 nuclear utilities. Sixty percent of those surveyed indicated that a site-specific study had been performed to estimate the costs of decommissioning. These estimates were based on well established techniques and on experience with decontamination, demolition and disposal. These activities can be accomplished today with current technology, although future improvements in technology will enhance the industry's ability to conduct these types of activities.

The cost estimates currently on record vary over a fairly wide range. This variation can be explained in large part by site-specific or utility-specific factors such as:

(a) Regional variation in labor rates.

(b) Amount of reinforcing in seismic structures.

(c) Type of plant (Pressurized Water Reactor or Boiling Water Reactor).

(d) Physical size of plant.

(e) Extent of removal of nonradioactive components and structures.

(f) Assumptions regarding plant operating history.

(g) Costs of the various components of waste disposal.

There are inherent limitations in applying a decommissioning cost estimate not specifically intended for a particular site-specific application. AIF (NESP) has recently completed (May 1986) a project to develop guidelines for producing site specific decommissioning cost estimates. Use of these guidelines can (1) achieve consistent cost estimates among various plants, the bases for which are well documented and relatable to site specific features, (2) facilitate periodic updates without completely redoing the overall cost estimate, and (3) support NRC's and the industry's objective of assuring that adequate funds are available for decommissioning a nuclear facility.

The guidelines were designed in a manner that will minimize the rate at which they may become obsolete. The task force overseeing the project included representatives from utilities, consultants, architect engineers, nuclear steam supply system vendors, and liaisons from NRC, National Association of Regulatory Utility Commissioners, FERC, and representatives from three State Public Utility Commissions. One of the objectives of the guidelines was to provide a reliable and widely recognized reference tool which will eliminate the need to refer to "generic" estimates; such generic estimates were not intended to serve as a site specific cost determination. It is hoped that the guidelines will help both the industry and regulators to avoid reliance in the future on generic decommissioning studies.

3. Proposed NRC Rule on Decommissioning

On February 11, 1985, the NRC published in the Federal Register (50 FR 5600) for public comment a proposed rule which would provide decommissioning criteria for nuclear facilities. Many utilities, consultants, vendors, and intervenor groups commented on the proposed rule. The final decommissioning rule is expected to be ready for NRC review by the third quarter of 1987.

Overall, the AIF Subcommittee and EEI compliments the NRC for the thorough job they have done in drafting this proposed rule after extensive research and gathering background information. The proposed rule offers many positive features that will be of assistance in the overall planning and implementation of acceptable decommissioning projects during the coming years; however, we still believe that present NRC regulations are adequate to protect public health and safety.

A number of key issues have been adequately addressed in the proposed rule. The proposed rule properly permits the use of the internal reserve funding mechanism for most utilities. (Under the internal reserve funding method, decommissioning funds are collected over the power plants useful life and invested in the utility's own assets which can be mortgaged in later years to raise cash for decommissioning.) In that connection, the NRC recognizes that the internal reserve method provides sufficient assurance of funds at the time of decommissioning. We also strongly endorse the NRC's statement that "Based on an analysis of the technical data base, decommissioning can be accomplished safely and at reasonable cost shortly after cessation of facility operation" (50 Fed. Reg. at 5603, Col. 3). Finally, we agree with the NRC that absent special circumstances, there is no need to prepare an environmental impact statement since the costs and environmental impacts at the time of decommissioning are small compared to the total costs and impacts of building and operating a nuclear power station (50 Fed. Reg. at 5610, Col. 1).

There are nevertheless several deficiencies in the proposed rule. I will briefly address what we conside the principal deficiency.

a) The NRC's $100 million Certification Amount

The proposed rule requires that Part 50 licensees submit either a site-specific decommissioning funding plan or a certification that financial assurance for decommissioning be provided in an amount at least equal to $100,000,000 (1984 dollars) adjusted annually for inflation. The NRC's objective for including this type of provision in the rule is to assure that adequate funds are available for decommissioning a nuclear facility at the end of its useful lifetime. As indicated earlier, the industry also shares this objective of assuring the availability of decommissioning funds when needed.

AIF and EEI submit, however, that the preferred approach is to base decommissioning cost estimates on site-specific studies, such as could be performed using the AIF/NESP guidelines. This would be preferred rather than including a specified minimum or generic amount that the NRC has described as "sufficient" to cover decommissioning costs for "most" power reactor licensees (50 Fed. Reg. at 5606, Col. 3). One of the major problems facing a utility is the need to assure that electric rate regulators use decommissioning cost estimates that are both adequate and realistic for the plant in question in establishing the rates for collecting these funds. Experience has shown that rate regulators, particularly the FERC, often rely heavily on NRC-sanctioned generic cost estimates which typically are too low. The availability of periodically updated site-specific decommissioning cost estimates will provide rate-regulatory bodies with more accurate information and avoid inappropriate reliance on generic studies in the rate process.

In this connection, it is the judgment of AIF and EEI that the $100 million identified in the proposed rule is not representative of the decommissioning costs for most of today's nuclear power plants. Current experience with site-specific studies of large-scale nuclear power plants have shown the costs to be substantially higher. Therefore, the rule should encourage the use of site-specific studies in lieu of a generic certification amount.

Any funding level specified in the proposed rule should be sufficiently high so that it is adequate to include realistic decommissioning costs. Adopting an inadequate amount in the rule may be misleading in rate proceedings and could be counter-productive to NRC's objective of financial assurance. (Let me add that there have already been several rate cases where regulators have limited the amount to be recovered to the proposed rule's $100 million certification amount rather than the utilities' higher site specific cost estimates). In addition, the NRC should specify clearly in the rule what this certification amount is to include, such as contingencies, structures (radioactive versus non-radioactive) etc., so there will be no misunderstanding as to its intended scope.

In summary, the principal deficiency of the proposed rule is the conclusion that $100 million will "provide sufficient funds" to cover the costs to decommission "most" power reactors. The $100 million figure is based on generic cost studies which depict decommissioning costs in terms of an order of magnitude only, and it can substantially understate the cost to decommission a particular large scale commercial power reactor. Moreover, the practical effect of the $100 million certification alternative may be to fix that amount as a funding ceiling in rate cases, despite a utility's demonstration in a site-specific cost study that a larger amount is required. That result is plainly contrary to the NRC's objective of assuring adequate decommissioning funding.

4. Need to Put Decommissioning Costs in Context

Having discussed the need for site specific cost estimates, I would like to put decommissioning costs in the context of other utility costs.

Although in absolute terms the cost of decommissioning is substantial, in relative terms the cost of decommissioning is not large when compared with electric utilities other costs of doing business. If I might use my own company, Northeast Utilities, as an example, if we were required today to decommission our Millstone Unit No. 2 at a cost of $145 million (assuming it was all spent in one year, which is highly unlikely since these costs are normally spread over several years), this would represent less than 7 percent of our current annual revenues and less than 22 percent of our calendar year 1985 construction program requirements.

5. Decommissioning Funding

I would now like to turn briefly to a discussion of decommissioning funding.

As the Committee may be aware, there are several different methods for funding decommissioning. Each decommissioning funding method has a different net cost to ratepayers, depending on the income tax and ratemaking treatment applied to the dollars collected and the return the accumulated dollars earn.

The relative costs of the various funding methods have been the subject of considerable analysis. (NUREG-0584, Rev. 3 at 13-30.) The generally accepted estimate is that the cost of external sinking funds and prepayment is approximately 2 to 3 times, respectively, the cost of the internal reserve. That estimate is adopted by the Regulatory Analysis underlying the proposed rule (at page 15).

a) Internal Reserve

The internal reserve funding method, which I referred to earlier, is the one that is presently in place for most utilities. It is comprised of an internal, unsegregated reserve, with the accumulated funds being reinvested in utility property. Currently, the internal reserve is the least costly decommissioning funding method for our customers.

With the internal reserve funding method, the estimated cost of decommissioning is incorporated into the depreciation expense the company recovers through rates. This provides for recovery of decommissioning costs over the life of the plant.

The NRC's proposed decommissioning rule properly recognizes that the internal reserve method provides reasonable funding assurance and is appropriate for most utilities. The internal reserve is also favored by most ratemaking agencies (the 1985 Edison Electric Institute survey referred to earlier shows that 57 percent of the utilities surveyed use an internal reserve). I should also note that the NRC, its Staff and consultant, Professor J. J. Siegel, of the Wharton School of Finance, have each concluded that the internal reserve meets the NRC's reasonable assurance standard. Professor Siegel concluded that the internal reserve, "provides excellent assurance of the availability of funds" for decommissioning (NUREG-0584, Rev. 3 at 49 and NUREG/CR-3899 at 13).

Furthermore, the fact that internal funds are held by the utility rather than an independent financial institution does not detract from the excellent assurance that internal funding provides or increase vulnerability relative to other methods (50 Fed. Reg. at 5609, Col. 1). In fact, in contrast to other methods, the internal reserve improves the utility's financial integrity. This is because the internal reserve may be used to purchase utility assets or reduce debt from utility operations, which enhances the utility's ability to generate funds internally and reduce external financing. The capital markets recognize these benefits and they are reflected in the cost of the securities the utility issues. This financial strength will help generate external funds for decommissioning at the lowest possible cost.

In sum, the standard that governs the NRC's evaluation of alternative funding methods is "reasonable assurance," and the choice between alternative funding methods meeting that standard is for state and federal rate regulators to make, with due regard for the circumstances in individual cases. Because the internal reserve method provides reasonable funding assurance, it is appropriate for use by utility licensees.

b) Leave the Choice of Funding Methods to the Rate Regulators

Finally, as indicated above, it is our position that the choice among decommissioning funding methods is for rate regulators to make.

This is consistent with previous NRC decisions in which the NRC concluded that the choice between particular funding arrangements, such as funded reserves, escrow accounts, depreciation allowances, etc., should be left to rate regulatory agencies in view of their legal responsibilities and the specific needs of individual utilities.

C. Concluding Remarks

I would now like to sum up the material that has been discussed with you this morning.

1. From a technical and financial standpoint, the current NRC regulations as applicable to decommissioning in 10CFR 50 are adequate for terminating a power reactor license.

2. The NRC's regulation should not specify an amount for decommissioning due to the numerous variables for each plant. Rather, a site specific study would determine the appropriate decommissioning costs.

3. Maximum flexibility should be included in those regulations in order to accomodate technological developments that are expected to occur during the lengthy period prior to commencement of decommissioning at most, if not all, of the reactors operating today.

4. The AIF/NESP study on decommissioning cost estimate guidelines will provide licensees a methodology for developing site-specific cost estimates that will be accepted by regulators.

5. On the issue of financial assurance the ratemaking and regulatory process is the cornerstone of the electric utility industry's financial structure and integrity. It is in place and it works. Nearly all utilities are currently collecting decommissioning funds.

6. Questions as to the choice of a specific funding mechanism are properly for rate regulatory agencies to decide, and that the internal reserve method provides reasonable funding assurance.

7. I also encourage you to consider decommissioning costs in context. For large electric utilities, expenditures of this magnitude are not unusual.

8. Finally, as I mentioned earlier, decommissioning can be accomplished by technology available today. While a number of devices and techniques are presently under development, successful decommissioning does not depend upon any technological breakthroughs or advances in present-day technology.

That concludes my presentation on the financial and technical needs of the utility industry relative to decommissioning. On behalf of the Atomic Industrial Forum and Edison Electric Institute, I want to thank the Committee on Science and Technology for your patience and attention this morning. I would like to offer our assistance to the Committee on issues related to decommissioning. I will be glad to answer any questions you have at this time.

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EDUCATIONAL AND PROFESSIONAL
BACKGROUND OF
LAWRENCE H. LEVY

I received a Bachelor of Mechanical Engineering in 1967 from the City College of the City University of New York and a Masters of Mechanical Engineering in 1971 from the same school. I also received a Masters of Business Administration in 1976 from the University of Connecticut.

From 1967 to 1972 I worked as an engineer with the Consolidated Edison Company of New York in their Mechanical Engineering Department and as a production engineer at one of their large fossil stations. In 1972 I joined Northeast Utilities Service Company as an associate engineer in the Mechanical and Nuclear Engineering Department. In that capacity, I worked on numerous nuclear-related assignments, including systems design review of Millstone 3, installation of the radwaste system at the Connecticut Yankee nuclear plant, coordination of numerous responses to Nuclear Regulatory Commission inquiries and development of the Quality Assurance Category I Material, Equipment and Parts List for the Connecticut Yankee nuclear plant.

I currently serve as a Consultant to the Senior Vice President of Nuclear Engineering and Operations, and I am responsible for: (1) preparation and coordination of testimony regarding nuclear facilities, backup information papers and responses to data requests for rate cases, (2) review of Securities and Exchange Commission financial reports and (3) various administrative activities such as preparation and coordination of the annual expense budget for three corporate divisions and investigation of monthly expense budget variances. I am a member of the Northeast Utilities Nuclear Speakers Bureau, and have made numerous presentations before professional and civic organizations on matters related to nuclear energy.

In addition, I served on the Millstone 2 Nuclear Review Board and the Millstone Site Nuclear Review Board, performing assessments of plant systems modifications and operating procedures to ensure such changes would not adversely affect public health and safety.

Since 1975 I have been involved with formulating NU's position on nuclear plant decommissioning and authored the engineering studies which developed costs and analyzed decommissioning alternatives for the Millstone and Connecticut Yankee nuclear power plants. These studies, which have been continually updated and used in numerous rate hearings, have been widely distributed to many utilities, consultants and federal agencies. I am the NU rate case witness concerning nuclear decommissioning for the past several years.

I am Chairman of the Atomic Industrial Forum Subcommittee on Decommissioning, a group which has provided comments to the NRC and the Federal Energy Regulatory Commission (FERC) concerning the electric utility industry's decommissioning position. This committee has published a position paper on decommissioning which has been widely distributed to state and federal regulatory bodies. In September, 1984, I was a member of a utility panel to present comments before the Commissioners of the NRC concerning the industry's viewpoints on the proposed NRC rule on decommissioning.

I have served on the technical program committee and as a session chairman at the 1979 American Nuclear Society Conference on Decontamination and Decommissioning of Nuclear Facilities which was attended by more than 400 persons, with both domestic and international utilities represented. I have also presented a paper on the "Utility Perspective of Nuclear Facility Decommissioning" at the 1982 International Decommissioning Symposium sponsored by the United States Department of Energy.

Mr. VOLKMER. Thank you very much, Mr. Levy.

Mr. Crimi, I would like to start with you. As I understand Mr. Voigt's testimony, one method of transferring technology is to use numerous subcontractors in the decommissioning process. What are the drawbacks to expanding the subcontractor base, or are there any?

Mr. CRIMI. I can't think of any real drawbacks. If I was to list one, I would say that from my perspective it means every time I bring on a new subcontractor, I have to train and bring the subcontractor's people up to a level of knowledge and understanding of our radiological controls, our safety standards, et cetera. So from a decommissioning/contractor standpoint, the disadvantage is I am continually training people, but from an industry-wide standpoint, I think it is an excellent way of getting a good industrial base in the decommissioning field, rather than having one or two companies capture that all.

Mr. VOLKMER. Now, my problem with that, to some extent, what we are doing at Shippingport and doing it then—from previous testimony according to Dr. Ross is that we won't be doing this again probably until some time in the 1990's, late 1990's.

Mr. CRIMI. That's correct.

Mr. VOLKMER. Now, some of these people probably won't even be around in this industry, is that correct, that you are training, or do you assume that they are going to stay on and wait around for something to happen in 1990?

Mr. CRIMI. Well, these are the same companies, though, that are currently servicing the operating reactors, so they are not sitting there waiting for more decommissioning. They are the same companies that today are servicing, doing modification work, processing wastes for the operating plants. They now have an interest in decommissioning, and they are getting involved in that.

Mr. VOLKMER. If they have to remove piping or anything like that, it would be the same people doing it.

Mr. CRIMI. Yes.

Mr. VOLKMER. So you envision these same people continuing the work in this field, all remedial wastes and anything like that in that same field right along.

Mr. CRIMI. Yes.

Mr. VOLKMER. OK. Do you see any further expansion of this subcontractor base, or do you think that it is pretty well in line with the what has been proposed.

Mr. CRIMI. I feel it is pretty well balanced right now.

Mr. VOLKMER. When you started in the decommissioning, what documentation was available on Shippingport?

Mr. CRIMI. OK, there was an important thing that was done on Shippingport by the Department of Energy that the industry ought to note and take heed of. They spent something like 3 years preparing a decommissioning plan which consists of 12 volumes of activity specifications. It has in it the alternative studies that were made, like on the pressure vessel removal. They gave us an excellent starting place for our planning. We are using that decommissioning plan as our basic plan.

We modify it when we see we can do something more cost effectively, but we take that basic decommissioning plan and then put detail on it to convert, say, an activity specification into a biddable package that we can send out to industry for competitive bidding.

Mr. VOLKMER. All right, you mean competitive bidding on part of the decommissioning?

Mr. CRIMI. On part of the decommissioning work.

Mr. VOLKMER. That is where the subcontractors would come in.

Mr. CRIMI. Yes.

Mr. VOLKMER. And they would do certain parts. In other words, you are really segmenting the decommissioning into part and parcel of the plant that had to be decommissioned and decontaminated, et cetera.

Mr. CRIMI. For example, we just a few months ago placed the contract for removing all of the primary system piping and components and equipment, competitively bid it, lot of interest in the U.S. industry and the responsive low bidder was selected and is on site working now.[47]

Mr. VOLKMER. All right. Now, at the time he started again, did the plans that you were furnished accurately reflect the location and history of plant components?

Mr. CRIMI. Yes.

Mr. VOLKMER. And that included the actual usage of them and how long they have been in use?

Mr. CRIMI. Yes, the plan had in it a very detailed radionuclide inventory of each of the components, the piping, so we had a real good starting point.

Mr. VOLKMER. Did you find any so far that you worked on where the plant documentation did not actually correspond to the hardware that was there?

Mr. CRIMI. The as-built drawings on the nonsafety part of the plant, like the secondary systems, are not necessarily 100 percent up to date. The as-built drawings on that portion of the plant are not up to date. They have [48] not been a problem, though. Our engineers go into the field and confirm the drawings before we actually start to do our detail engineering.

Mr. VOLKMER. As I understand it, also, some of the plant's operating crew are available or have been available. Does that affect the decommissioning, in your opinion?

Mr. CRIMI. It is an excellent source of knowledge,[49] what has happened on that facility. We have assigned to us—we had three Duquesne Light people: One, a maintenance expert, one was an operational, and one is a middle management person. We are down to the maintenance person and the middle management, and we have used them from time to time to provide input on what happened in a particular area where the records didn't necessarily indicate all the facts.

Mr. VOLKMER. OK, now a December 1979 Nuclear Regulatory Commission report, "Facilitation of Decommissioning Light Water Reactors," recommended both the use of computer modeling for mapping and avoiding radiation hazards and computer access to a data base on decommissioning literature. Are such suggestions in use at Shippingport?

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[47] Mr. Crimi clarified his response: ". . . components and equipment. We competitively bid it, received a lot of interest from U.S. industry and the responsive low bidder was selected and is on site working now."

[48] Mr. Crimi changed "They have . . ." to "That has . . ."

[49] Mr. Crimi inserted the word "and".

Mr. CRIMI. Yes, we have available to us the literature that has been generated. RAPIC is one of the groups at Oak Ridge that—Remedial Action Program Information Center—that we call to provide reports on different aspects of decommissioning or decontamination. So, yes, we have been able to make use of some of those reports.

Mr. VOLKMER. My question goes a little bit further than that. Do you have computer operators presently in existence up at Shippingport that can program right into their information data base to pick it up, or do you have to contact them, and then furnish it to you? I mean by telephone, by person, or what? Or, do you have direct access?

Mr. CRIMI. If it is data that doesn't reside at Shippingport, then we have to make contact either by phone or write a letter, and the information is provided to us, but the data that we are accumulating at Shippingport is all going into a computerized program.

Mr. VOLKMER. So that is simultaneously being put into some computer data base somewhere.

Mr. CRIMI. Yes, right there on site.

Mr. VOLKMER. On site.

Mr. CRIMI. Yes.

Mr. VOLKMER. Now, you also mentioned your innovative techniques that you are utilizing every once in a while instead of the program as set out in the decommissioning report by the DOE. Can you describe any of these techniques?

Mr. CRIMI. Yes. There was some mention earlier about plasma arc cutting. True, we're not plasma arc cutting the pressure vessel, but we are using plasma arc cutting, both under water and in air, and again, this is being done through subcontractors, and one of the innovative techniques that we utilized for plasma arc cutting in air, where historically you will put the people that do the plasma arc cutting in anti- "C" clothing with respirators and put them to work inside of containment making the cuts, we came up with a box which is ventilated through a HEPA filter, so the operator can stand outside, look through a window in the box and work through gloves to operate his plasma arc cutting equipment. His exposure is reduced, his probability of inhalation exposure is reduced, and the job goes much faster.

Mr. VOLKMER. In other words, therefore, the number of rems that he could be subject to is reduced, and therefore he can be exposed longer.

Mr. CRIMI. That's correct.

Mr. VOLKMER. Which helps you as far as labor time.

Mr. CRIMI. Yes.

Mr. VOLKMER. Now, I believe you mentioned in your testimony that somebody at Hanford is responsible for the actual transportation of the wastes?

Mr. CRIMI. Well, we are responsible for getting the waste packaged and making the arrangements for transportation, be it by truck, barge, or whatever. Once it gets to Hanford, it is offloaded by Rockwell/Hanford operations, who is one of DOE's contractors at Hanford, and then they offload the trucks, and right now are storing the wastes on a pad waiting for a final decision as far as the burial configuration.

Mr. **Volkmer**. Now, in the event that there is an accident on the way to Hanford, one of these trucks that is picking some of this stuff up, who is liable under your agreement on that?

Mr. **Crimi**. Well, first of all, each truckdriver is given an emergency packet, and we have an emergency plan which covers an accident en route. We would be one of the first groups contacted. As far as the liability, ultimately, we are protected through our contract by DOE.

Mr. **Volkmer**. DOE? All right. In other words, if a truck, through bad driving of the driver, runs off the road somewhere and hits a big ditch and spills everything out into the town somewhere, DOE is the one that is going to be responsible if there is any damages.

Mr. **Crimi**. Ultimately, it would go that way. Obviously, we have a responsibility to make sure we pick a reputable trucking firm.

Mr. **Volkmer**. Oh, I understand that. I all understand all that. Let's assume all that, but I am just trying to get to—any cleanup, who would be responsible for that?

Mr. **Crimi**. Again, DOE would call upon us to provide the planning and the supervision and whatnot, but the cost would be borne by the Department of Energy.

Mr. **Volkmer**. Go back to DOE.

Mr. **Crimi**. Yes.

Mr. **Volkmer**. You mentioned some innovative things that you have done, but what have we learned in the decommissioning methods or technologies through Shippingport, and so forth?

Mr. **Crimi**. The point I am trying to leave is that the technology exists today. There is really no need for new technology development. But when you do something like this, new technology does come to the surface. For example, in the area of asbestos removal—and remember now, this plant was built in the midfifties, so all of the insulation—most of it is asbestos, and our subcontractor came up with this here.[50] We are using a wetting agent that penetrates the asbestos, its full thickness, 5 to 6 inches, encapsulates the asbestos fibers so that the amount of asbestos you get when you cut into it to remove it is greatly reduced.

Mr. **Volkmer**. You mean the asbestos dust.

Mr. **Crimi**. The asbestos dust, that's correct. We don't rely on that, though, as our means of protecting the worker. The worker is still fully suited in his asbestos suit, his respirator, he has an air sampler, but it is a very good technique for removing asbestos.

Mr. **Volkmer**. OK, my question is: If we are not learning any new technology, what are we learning from it?

Mr. **Crimi**. I think what we are learning, we are going to demonstrate to the world, once and for all, that you can do a decommissioning safely and cost-effectively. I think that is what is going to come out of it.

Mr. **Volkmer**. Instead of an R&D type of thing, it is more of a demonstration.

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[50] Mr. Crimi changed this to read ". . . and our subcontractor came up with this technique".

Mr. CRIMI. A demonstration project, absolutely.

Mr. VOLKMER. Is there any utilization of information obtained from cleanup at TMI, Three Mile Island?

Mr. CRIMI. Yes, we get a weekly report from TMI telling us what they are doing, and we also get the benefit of some of the reports that they have issued to date. Decontamination reports have been issued and some of the other work that is applicable to Shippingport.

Mr. VOLKMER. Are we learning anything in methodology to reduce the volume of the waste generated?

Mr. CRIMI. Yes, one of the things that we feel [51] is that we have to protect the environment. It [52] is only so much of it out there, and we can't fill it up with waste, and we have a very conscious program to reduce the amount of volume that we ship out. We take the extra time to fill these LSA [low specific activity] boxes; when you fill it with radioactive piping and other material to [53] take other baggable wastes and put it into the nooks and corners so that we have a maximum amount of waste. We are compacting waste where it is compactable, so, hopefully, we will be able to demonstrate that we can reduce the amount of total waste that has to be buried by some of these techniques.

Mr. VOLKMER. I recognize the gentleman from California for any questions he would like to ask.

Mr. PACKARD. Thank you, Mr. Chairman. How did General Electric get the contract? Was it by competitive bidding?

Mr. CRIMI. Yes, the Department of Energy used a Source Evaluation Board and went out to industry for competitive bids, and there were several criteria. Two of the criteria that everybody was then considered had to meet was the experience base of the people and the experience of the company in doing this type of work. They had to demonstrate that they were doing at least $50 million a year for the past 3 years, and this goes back to 1983, of "D&D" type work to be considered further.

Mr. PACKARD. Going through that initial process and the first time that there has been competitive bidding for such a project as decommissioning, do you see that there will be an adequate number of contractors and subcontractors to meet the need of, say, 20 to 30 years from now?

Mr. CRIMI. I feel there will be. Everybody is interested in getting into the decommissioning field because it really represents the last part of the fuel cycle.

Mr. PACKARD. How many workers are employed for the decommissioning of Shippingport?

Mr. CRIMI. In my organization, what we call the DOC, the Decommissioning Operations Contractor, we have approximately 105 workers. Forty-one or so are General Electric, about another 30 Morrison-Knudsen, and the others are local subcontract people that we picked up in the area. The people, then, that are doing the actual decommissioning, that number fluctuates, but today we have about another 70 or 75 subcontractor people completing asbestos removal, subcontractors for removing components and so forth that fall in that second category. So the combination of the two is about 175, approaching 200.

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[51] Mr. Crimi changed "feel" to "believe".

[52] Mr. Crimi changed "It" to "There".

[53] Mr. Crimi changed "to" to "we".

Mr. **Packard**. And how will the decommissioning of a 5- to 100-to 1,000-megawatt plant differ in terms of personnel than what you are experiencing?

Mr. **Crimi**. I think the difference will be a function of the radiation levels of the plant being decommissioned. Shippingport is a clean plant, and incidentally it is clean because Duquesne Light paid attention to detail when they were operating, in their water chemistry control. When they did maintenance and opened up the systems, they maintained cleanliness so particles wouldn't get into the system, and it was also mentioned that part of the last quota [54] was decontaminated.

The difference is going to be in the radiation levels. If you have high radiation levels, you have got [55] a burnout factor in the workers, so you may require and probably will require more workers to accomplish the work so that you can stay within the regulatory limits of exposure for those people.

Mr. **Packard**. Does that mean that you would have to then stagger shifts and handle your shifting of workers?

Mr. **Crimi**. Well, you can't just change the shift of the people. You have to have more people in order to do it, because once they have reached their exposure limit, they can't work in a radiation area. You can go put them on nonradioactive work, and certainly the contractor would do that, but they will require more people if the radiation levels are higher.

Mr. **Packard**. Mr. Levy, in your testimony you state that the NRC regulations are not needed or that new regulations are not needed, and that the current rules do not allow for adequate flexibility, or the new rules don't.

What do you recommend? Do you believe that the current regulations will provide a reasonable assurance that the utilities will have the financial resources for decommissioning—just expound a little bit on why you feel that the regulations are adequate.

Dr. **Levy**. Well, the regulations that are in place right now—10 CFR 50.51 and 50 882, I believe it is—give us the flexibility, the types of methods; along with regulatory guide 1.86, tell us which methods are appropriate; that is not changing with the new rule. The old regulations do not delve into the funding requirements, and was mentioned before in, maybe, question and answer in the previous panel, most State utility commissions are collecting for decommissioning at this point in time. It is not one or two isolated utility commissions that are doing that. Almost all are. They might not be collecting the total amount that they are requesting because of the problems that I mentioned in my testimony, but they are collecting for decommissioning right now, and it is certainly recognized by the FERC, as well as the PUC.

It is really the funding part of the new rule that we are taking a major objection to, specifically the $100 million certification mark amount. We feel that there shouldn't be any number in there at all. Site-specific studies are really the way to go, and if the NRC doesn't believe the utility site-specific study, well, then they can do their own for any particular plant.

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[54] Mr. Crimi clarified this to read ". . . it was also mentioned that prior to the last core, the plant . . ."

[55] Mr. Crimi requested deletion of the word "got".

But it is important that we get away from generic studies and get away from numbers that could be artificially low—or artificially high, for that matter—and as I mentioned earlier, the ceiling at $100 million certification put on the utilities, the regulators are using that as a ceiling to prevent utilities from collecting the proper amount for decommissioning, and that is a real key point.

They are doing that in practice, even though it might not be apparent in the rule, but it is being done in practice right now, even though it is proposed rulemaking.

Mr. **Packard**. So you are saying that most States now, the PUC's that are authorizing and requesting the collection of the funds, are doing it on the basis of the $100 million figure rather than site-specific.

Dr. **Levy**. I wouldn't say the $100 million figure so much for all States. Some States do that. Most of them do it on generic cost estimates, particularly the Federal Energy Regulatory Commission. They will not look at a utility site-specific estimate. They believe in the NRC generic study, and they won't deviate from that at all, and I know from personal experience from the latest rate case that my utility has had, they refuse to budge. They say the Battelle study is what we are going to use throughout the country, and no matter what you say, this is it.

Mr. **Packard**. Do you know what California's generic figure is, if they have one?

Dr. **Levy**. No, I don't.

Mr. **Packard**. It would appear to me that where there are seismic problems, and they have to address the construction of their plants to seismic issues, that it very well could reflect in the cost because of the increased reinforcements and so forth could increase the cost of decommissioning.

Dr. **Levy**. No question. And that is the reason for site-specific studies such as the San Onofre, which is near or close to a fault line. Those costs would be substantially higher because of the seismic requirements that were built into the structures. A plant like in the Northeastern part of the country wouldn't have those seismic structures as well as the San Onofre plant would.

Mr. **Packard**. In the rules, it identifies three specific ways of decommissioning. Do you feel that there ought to be more flexibility in that area, or do you feel that those three ways of decommissioning would adequately cover the waterfront?

Dr. **Levy**. I think that those three methods adequately cover it right now, and that is in the existing rules right now. Regulatory guide 186 specifically lays out each of the rules, and we were certainly in agreement that complete dismantlement, mothballing or entombment with a delayed dismantlement with the mothballing and entombment would be appropriate methods. We have no argument with that at all.

Mr. **Packard**. Do you feel that it is necessary for rules to be issued defining which waste requires special treatment and which ones do not?

Dr. LEVY. Yes, we do.

Mr. PACKARD. Mr. Crimi——

Mr. CRIMI. Crimi.

Mr. PACKARD. How long do you expect it to take to finish the decommissioning of Shippingport?

Mr. CRIMI. Our contract requires us to be completed by January 1990. We are going through a planning session right now to ensure we meet that date, but we actually are accelerating it in certain places, so if the funding is made available to us, I see no problem in accomplishing that end point.

Mr. PACKARD. You mentioned also in your testimony that you are a little ahead of schedule in terms of costs. Do you expect that to continue, and if so, how do you think it will come out in terms of your projected costs?

Mr. CRIMI. Well, again, because we have an incentive-type contract with DOE and I share in the cost underruns, my intent and my charter is to make sure that an underrun continues to grow.

Mr. PACKARD. It is to your benefit, then. It is not a bad way to deal with it. I wish we could make every Federal procurement program work on the basis—to give incentives to come in low rather than high.

I have no further questions, Mr. Chairman.

Mr. VOLKMER. The gentleman from Illinois.

Mr. FAWELL. Yes. Dr. Levy, I would like to put these questions to you. I have been educated, and recognize now that the estimated costs of decommissioning, costs of decommissioning, are incorporated into most utility rates, and the generic mode is used most of the time, I gather, is that correct?

Dr. LEVY. That's correct.

Mr. FAWELL. And then you had made reference to the internal reserve method as opposed to the sinking method. What is the difference between the two?

Dr. LEVY. I am going to let Mr. Geruch answer that. He is a bit more knowledgeable on this.

Mr. GERUCH. OK, the external funding methods are where funds are set aside external to the company. They are usually invested in some sort of outside securities, bonds or stocks of various companies. In internal funding, the money is retained internal to the company. It becomes part of the normal cash flow or cash operations of the company, and it is generally used to finance new assets for the company.

Mr. FAWELL. Now, at the present time you are not limited by that $100 million cap to which reference has been made, though, is that correct?

Mr. GERUCH. In the case of our individual utility, no.

Mr. FAWELL. That is something in the new rules?

Dr. LEVY. That's something in the new rules, but some utilities are being limited by their State PUC's. They are pointing to this rulemaking saying: "Well, if $100 million looks like the maximum amount or the minimum amount for decommissioning from the NRC point of view, well, then, that is all we will grant you." Because intervenors and consumer counsels are trying to limit the amount of utilities requesting the proper amount for decommissioning, that is simply what happens. It puts a ceiling on the amount recovered.

Mr. **Fawell**. The estimated costs of decommissioning are incorporated as depreciation expense; is that correct?

Mr. **Geruch**. Yes; it is basically an amortization over the life of the facility.

Mr. **Fawell**. Does that vary as these cost estimates vary?

Mr. **Geruch**. Yes; there are all different schemes for recovering that money. You can just take the amount and divide it by the service life, and have what is called a straight line writeoff. There are ways of accelerating the collections or decelerating the collections.

Mr. **Fawell**. Now is it correct to say, then, the basic difference between the sinking fund and the internal reserve—basically the sinking fund is a trust fund that can only be used for prospective costs of decommissioning, and the other is mixed into the general funds, and I assume spent.

Mr. **Geruch**. Yes; except I would suggest you not call it a sinking fund, and call it an external fund. There are a number of sinking fund options, some of which are internal also.

Mr. **Fawell**. Are there some groups that raised some objections to these expenses being utilized in general as funds that can be used for any expense?

Mr. **Geruch**. Yes; and that is where you will see most of the comments in the regulations heading toward, which is the financial assurance aspect. There is concern that money invested into the utilities' new assets or new growth will not be available at the time of decommissioning. Whereas there is this perception that money that is invested in outside securities is much more easily available at the time of decommissioning.

Mr. **Fawell**. What, roughly, is the division of the States in their taking positions in that regard?

Mr. **Geruch**. I would say as a result of the recent change in the tax legislation, which allows for the tax deductibility of trust payments, more States are opting to go to an external funding concept.

Mr. **Fawell**. NRC has not taken any position. Both are deemed to be reasonable funding assurances?

Mr. **Geruch**. Yes, they have come out and supported both methods. They have done a good job on explaining the pros and cons of the various methodologies and the economies of each methodology.

Mr. **Fawell**. Which would you recommend?

Mr. **Geruch**. It depends what my governing rule would be. If it was strictly to hold the cost of electricity to the lowest amount possible to the ratepayers, then I would suggest that the internal funding methods be followed. If my concern is that the public needs to be made assured that there is funds, in fact, readily available to do a decommissioning at that time, then I would opt for an external funding.

Mr. **Fawell**. One more question. Why would the internal reserve funding be of less cost overall?

Mr. **Geruch**. The internal?

Mr. **Fawell**. Yes.

Mr. **Geruch**. The internal fund earns for the ratepayer at a much higher earnings level. It is part of the ratemaking concept where this—first of all, think of the collections as a prepayment of a future expense. Because this expense is prepaid by the customer, we reflect it in a reduction to our rate base—generally throughout the utility industry, our returns on our rate bases are in the area of about 22 percent—so by reducing our rate base, the customer is earning 22 percent on his funds.

If he gives us this cash and we turn around and invest it in outside securities, we kind of look at maybe a 7-percent return on that money, that is further offset by the fact that you have taken cash out of the mainstream of the company, and that company must now go and finance an amount equal to that amount of money, and that with it alone carries an additional cost, so when you look at the overall picture, an external fund results in little, if any, earnings for the ratepayer as opposed to an internal methodology where he may earn 22 percent on that money, and that is what gives you the large discrepancy in cost differentials.

Mr. **Fawell**. I have no further questions.

Mr. **Volkmer**. I would like to continue just briefly, though. The external fund, of course, will have earnings.

Mr. **Geruch**. Yes.

Mr. **Volkmer**. Assuming that everything goes right and the stock market doesn't go kaput, or that the interest rates don't go down to zero or something like that.

Mr. **Geruch**. And also complicated by the fact that at the time you decide to sell these securities, the market may be high or low.

Mr. **Volkmer**. I understand all that. So there is a possibility, but on the other hand on the internal, what is the methodology used in order to determine the amount of return that is on the internal fund that should be added to the fund to provide for decommissioning, or is there any at all? Is there any accounting at all?

Mr. **Geruch**. No, it is a straight amortization from the standpoint that if the cost is $200 million, we recover $200 million through rates. The earnings of having that money prematurely by the company is reflected through other cost aspects of ratemaking, not through the decommissioning costing.

Mr. **Volkmer**. In other words, it goes into your actual returns that you have to show to the regulatory body in order to determine whether or not you should have a future increase or decrease or what.

Mr. **Geruch**. Yes.

Mr. **Volkmer**. Just like all other income has gone into it; is that correct?

Mr. **Geruch**. Exactly.

Mr. **Volkmer**. So it is really up to the ratemakers actually how much benefit the ratepayer gets from it.

Mr. **Geruch**. Yes, and they are in an awkward situation, again, because they have to decide whether it is an internal funding method or an external funding method.

Mr. **Volkmer**. But once they have determined it as an internal funding method, from then on if your utility, and I agree that an internal funding method may be viable for larger utilities. I also have to agree with NRC that for a small utility I would seriously question the usage of an internal, because I don't know if they are still going to be there when the time comes if things don't go too good as far as that utility is concerned. Do you agree with that?

Mr. GERUCH. That individual utility may not be there, but I don't believe the utility service for that area would ever go away, and that in fact there would be some successor utility which is picked up on those responsibilities.

Mr. VOLKMER. Would accept that responsibility and that cost.

Mr. GERUCH. I presume so.

Mr. VOLKMER. All right, what I am trying to get at is in this internal fund which you utilize and, hopefully, make money on, what happens to the additional funds? Now you have got, let's say, the $200 million, and that has been amortized. To make it easy for me, I am going to do it on a straight line basis, and that gives me $5 million a year, and I have got $5 million, $5 million, $5 million, but at the end of 10 years, I have accumulated earnings on that equal to another $20 million.

What happens to that?

Mr. GERUCH. Those earnings are reflected as reductions to the rate levels required by the utilities annually.

Mr. VOLKMER. I understand what you are saying, then. So instead of me paying 5½ cents a kilowatthour, I may be paying 5¼ quarter cents or whatever it is.

Mr. GERUCH. Yes. It is coming in one pocket, and we are, so to speak, shelling it out through another pocket.

Mr. VOLKMER. Now, the last question I have, and then we are going to have to break for lunch, and I will ask you all to come back because I will have a few more questions for Mr. Levy I haven't asked yet. But to continue on with this—and Mr. Levy, you may have to answer this. My understanding of the utility regulation is that on what I call retail sales—which is to residential consumer sales, residential commercial industrial type—the rates for that are regulated by the State regulatory body, is that correct? Or wholesalers, where you sell to another city or something like that and they sell it off. Those are regulated by FERC, correct?

Dr. LEVY. Correct.

Mr. VOLKMER. Now, when you mentioned that—first holding you to this $100 million or $130 million or whatever it is that NRC is setting out, or proposed is setting—do they allow you to recover that, as well as the State regulatory body allows you to recover a decommissioning fund, have two funds?

Dr. LEVY. No, they are both separate. We go through the FERC with our Connecticut Yankee plant because Connecticut Yankee has joint ownership, and that sells electricity wholesale to different cities. Our State public utility commission does not deal with Connecticut Yankee at all.

Mr. VOLKMER. So we do not have instances where one plant is being dealt with for decommissioning by both regulatory bodies.

Mr. GERUCH. No, if I can correct that. One of our subsidiary companies—Connecticut Light & Power, for instance—is the owner of Millstone units Nos. 1, 2, 3. Those units actually fall under both jurisdictions. About approximately 97 percent of that unit is designated as retail or comes under retail jurisdictions or State jurisdictions. About 3 percent of those units fall under FERC jurisdiction as a wholesale supplier.

Mr. **Volkmer**. Who set the decommissioning funds for those?

Mr. **Geruch**. The way we reflect it, both. We reflect on the company's book of accounts the 97 percent allowance by the State and also the 3 percent allowance by the FERC.

Mr. **Volkmer**. Now, you are actually working with two different figured funds. Actually, if FERC says you are limited to $100 million and the State Regulatory says, "We will give you $150," you take 97 percent of $150 million and 3 percent of $100 million.

Mr. **Geruch**. Right.

Mr. **Volkmer**. That doesn't make sense, does it?

Mr. **Geruch**. Pardon?

Mr. **Volkmer**. That really doesn't make sense.

Mr. **Geruch**. I think it makes a lot of sense, because at some point in time when the plant is to be retired, and there is either additional monies to be collected or refunded to ratepayers, we would like to make sure the proper ratepayers be assessed or be credited those funds.

Mr. **Volkmer**. I agree. What I am trying to say—and then I have to run for this vote—it is either going to cost $100 million or $150 million, but it is not going to cost $100 million and $150 million.

Mr. **Geruch**. No, but until decommissioning takes place——

Mr. **Volkmer**. You really don't know how much.

Mr. **Geruch**. No, we will never know.

Mr. **Volkmer**. All right, we will recess until 1 o'clock and I will finish up the questioning.

AFTERNOON SESSION

Mr. **Volkmer**. I want to thank the panel for continuing the hearing and being here. I am sorry for the delay.

Dr. Levy, there was testimony earlier by the previous panel that the decommissioning of Shippingport is basically a demonstration project more than an R&D project; do you basically agree with that?

Dr. **Levy**. Yes, I do.

Mr. **Volkmer**. Do you believe that we will learn very much from Shippingport, as far as decommissioning?

Dr. **Levy**. I think we will learn some from Shippingport. I think, though, as utilities operate, and will continue to operate, we see, like, a removal of steam generators and taking care of those types of pieces of equipment. At our own utility we remove the thermal shield from the reactor vessel. Ongoing operations will help us in learning more and more about what it takes for a decommissioning.

I think Shippingport will add to that, but it is not the only source that utilities will use for that knowledge.

Mr. **Volkmer**. In other words, we are going to have a learning process from the utilization of the present reactors and making corrections and repairs on those?

Dr. **Levy**. That is correct.

Mr. **Volkmer**. Would you rate the physical size of the plant, or the level of radiation present in a reactor as the driving factor behind the difficulty in decommissioning; either one of you can answer that?

Mr. **Crimi**. I will take a crack at it.

Mr. **Volkmer**. All right.

Mr. **Crimi**. As far as the size is concerned, let me say one thing, people have been homing in on the megawatt rating of Shippingport, which is 72 megawatts; we really should be looking at the physical size of the pressure vessel, which is the most irradiated component in any nuclear plant. If you compare the Shippingport package, it is about 17 feet in diameter, and when we put the lifting beam on it, it will be about 41 to 42 feet long.

That compares to the 1,100-megawatt San Onofre pressure vessel, without any shielding, of 14½ feet, and about 43 feet with the pressure vessel head. So the most highly irradiated component at Shippingport is very much relevant to the large reactors.

Mr. **Volkmer**. The modern reactors?

Mr. **Crimi**. The modern reactors.

It is obviously very relevant to the older reactors. So, it is a point that we should keep in mind here when we think about Shippingport relevancy.

As far as the contamination is concerned, my experience, 30-plus years in this business, is that it doesn't matter whether you have a little bit of radiation or a lot, the controls required are exactly the same.

You can't afford to send people out, at the [56] plant that has little radiation, with contamination on their skin or their clothing or what not. The difference is going to be, as we stated earlier this morning, it will take more people because of the the burnout factor where the plant has more radioactivity associated with it. The control is the same.

Mr. **Volkmer**. You just add to the cost?

Mr. **Crimi**. That is correct.

Mr. **Volkmer**. Now, as spokesman basically for the nuclear utility industry, Dr. Levy, if Shippingport is decommissioned as presently planned, which I anticipate it will do, should there be a follow-on demonstration project to address the effect of scale on decommissioning?

Dr. **Levy**. Are you asking me should there be?

Mr. **Volkmer**. Yes.

Dr. **Levy**. I don't know if it is necessary to have a follow-on demonstration. I think we will see plants being decommissioned along through time. I don't when the next plant is after decommissioning—I guess Humboldt Bay with that sort of safe storage—but we have the Yankee Atomic Plant in Rome, MA, I think will be decommissioned in the mid-1990's. I know our own Connecticut Yankee Plant is in the early 2000 timeframe.

As I mentioned before, as the ongoing operating of the plant goes on, we learn more and more about it, of decontamination and removal of components. I don't think another demonstration plant is absolutely necessary.

Mr. **Volkmer**. Mr. Crimi, do you——

Mr. **Crimi**. I agree with that.

Mr. **Volkmer**. You agree with that?

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[56] Mr. Crimi changed ". . . at the . . ." to ". . . of a . . ."

Now, does AIF, Mr. Levy, agree with the statement that "this administration expects utilities, the nuclear industry, and industry-sponsored research organizations to develop the technology to decommission new commercial nuclear powerplants." Do you agree with that?

Dr. Levy. I guess, I am a little confused about the question.

Mr. Volkmer. "This administration expects utilities, the nuclear industry and industry-sponsored researched organizations to develop the technology to decommission commercial nuclear powerplants." In other words, it is not up to the government——

Dr. Levy. That is correct.

Mr. Volkmer [continuing]. To show you how to do it. It is going to be up to you after this to do it on your own?

Dr. Levy. Yes, I think we see from Shippingport that there are vendors out there who are able to take care of this type of facility operation of decommissioning. I think as you get closer and closer to decommissionings in the next century, vendors will be getting the expertise that is necessary to decommission, as they did for the construction of nuclear powerplants.

Mr. Volkmer. Will AIF, or some other industry-sponsored group be able to prepare the plans that were so well prepared by DOE for Shippingport, which Mr. Crimi has mentioned, has been such a great asset; who is going to do that for the commercial plant that comes up in 1997?

Dr. Levy. I think either consultants or the utilities themselves will be doing the plans for their own plant.

Mr. Volkmer. All right.

Is industry pretty well following what is happening at Shippingport?

Dr. Levy. I think we are aware of what is happening at Shippingport. I don't think it that important for utilities to be right on the scene at Shippingport.

The involvement of vendors to learn how to do the actual physical decommissioning is important to them. But for utilities, the main purpose is collecting funds now for the eventual decommissioning that won't occur for another 20 years.

Mr. Volkmer. You are basically relying on people like M.K. Fergerson, or General Electric, or Westinghouse, or people like that, and subcontracting people, to have the expertise when the time comes?

Dr. Levy. We will learn from the expertise of General Electric, and so forth, but as this evolves more and more in the next 25 years, I think we will learn more and more about what it takes to decommission, perhaps, more efficiently than is being done.

Mr. Volkmer. Let's assume for the sake of discussion, that come the 1990's, and many of the State regulatory commissions have limited utilities to $100 or $130 million, and we find ourselves far short for some reason or other, let's say it is going to cost $200 million; what can we expect the utilities to do about that—just go ahead and take the money out of their pocket?

Dr. Levy. Well, what is going to happen is the shareholders are going to have to pick it up. That is exactly what is going to happen, and the ratepayers will get away without paying.

Mr. VOLKMER. Unless you can go back to the State regulatory body and ask them to review it and ask for additional——

Dr. LEVY. That is true, but I really don't think that is going to happen. You want the people who are enjoying the advantages of nuclear power now to pay their fair share. If you wait until the end, those ratepayers are going to yell and scream, "look, we only enjoyed it for only a few short years, and now you are trying to get the revenues from us."

So I think the shareholders are going to be able to pick that up.

Mr. VOLKMER. All right.

Either one of you can answer this. As we look again to the future for the various elements of decommissioning costs, and now estimating what those costs will be, what would impact on costs more; do, like, increases in the physical size matter more than, say, reasonable wage rates, or does the operating history of a plant matter more than the type of plant?

Dr. LEVY. From my experience, I think, right away is burial costs have been the major factor in the increase in decommissioning costs. I don't know if that is going to continue in the future, but it has been in the past.

Maybe Mr. Crimi knows a little bit more about that?

Mr. CRIMI. I think that is correct. But, certainly, wage rates will have a very definite influence on where we peg the wage rates for decommissioning a plant.[57] It is a demolition job; it is not construction. So the wages ought to be pegged accordingly.

Mr. VOLKMER. Well, with that I would like to thank this panel. I appreciate your testimony here today.

If there are any additional questions they will be sent to you in writing. We would appreciate if you reply as soon as possible.

I thank you very much. We appreciate your testimony.

Our third panel consists of one witness, Ms. Cynthia Pollock. Ms. Pollock is a researcher on energy technologies and policies at Worldwatch Institute here in Washington. She is author of the recent Worldwatch paper, "Decommissioning: Nuclear Power's Missing Link."

Ms. Pollock, your paper will be submitted for the record. If you wish to summarize or give a statement, you may do so.

I don't believe it is necessary; I have reviewed your paper and I find it very worthwhile for background material. I did that over the weekend.

So, if you would just proceed with your testimony at this time.

STATEMENT OF CYNTHIA POLLOCK, RESEARCHER, ENERGY TECHNOLOGIES AND POLICIES, WORLDWATCH INSTITUTE, WASHINGTON, DC

Ms. POLLOCK. Thank you, Mr. Chairman. I would like to make a few brief oral statements in addition to the paper that I have submitted.

First, I will start with some of what we know about decommissioning. We know that reactors will wear out, probably after only several decades of operation. We also know that retired reactors will contain high levels of radiation. So in order to protect public health, these reactors must be cleaned up, dismantled and buried, the process known as decommissioning.

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[57] Mr. Crimi indicated this sentence should read "But, certainly, wage rates will have a very definite influence on cost. Where we peg the wage rates for decommissioning a plant".

We also know that nuclear reactors will only be fully dismantled if it is possible to remove the spent fuel from the reactor site. Commercial nuclear reactors, those owned by private utilities instead of the Department of Energy, do not at present have any place to which they [58] send their spent fuel.

And until either a high-level waste repository, or a monitored retrievable storage facility is established, decommissioning policy will be held hostage to the lack of disposal sites.

It is only possible to dismantle Shippingport because DOE is responsible for the decommissioning phase. Without this agreement Duquesne Light, like the other four utilities with retired reactors, would be unable to proceed with dismantling.

Work is now in progress to develop a high-level waste repository at one of three sites: Hanford, WA; Deaf Smith County, TX; or Yucca Mountain, NV, but it will not be open for business until at least the turn of the century. There are a number of plants that—which will have operated for more than 30 years at this time.[59]

Something else we know is that dismantling a retired reactor will produce large quantities of low-level nuclear waste. This waste is considered to be less toxic [60] than the spent fuel, but it is produced in far greater volumes.

Studies done for the Nuclear Regulatory Commission show that dismantling just one large reactor, one capable of producing 1,100 megawatts of electricity, will produce an estimated 18,000 cubic meters of low-level waste, or 1½ times as much as would be generated throughout a 30-year operating life; thus, each large reactor—and there are scores operating in this country—would produce enough waste to bury a football field under 12 feet of radioactive debris.

Shippingport will produce a smaller volume of waste, some 3,000 cubic meters, because it is physically smaller and [61]—approximately three quarters the size—of the pressure vessel of the large plants. It had a generating capacity of only 72 megawatts, less than one-tenth that of modern reactors. It was already thoroughly decontaminated once during its operating life; and it had several reactor cores.

In addition, as we have heard, at Shippingport no primary system decontamination will be conducted, alleviating the problems of solvent handling and disposal, nor is the need anticipated for cutting large sections of contaminated concrete.

The three operating low-level waste facilities in the United States, at Barnwell, SC, Hanford, WA, and Beattie, NV, are not large enough to accommodate these decommissioning wastes. Legislation passed in 1980, and amended in 1985, made each State responsible for managing the commercial low-level waste generated within its borders, and encouraged States to form regional compacts to establish and operate disposal facilities cooperatively.

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[58] Ms. Pollock requested insertion of the word "can".

[59] Ms. Pollock changed this sentence to read, "There are a number of plants that will have operated for more than 30 years by that time".

[60] Ms. Pollock changed this to read, "This waste is considerably less toxic . . ."

[61] Ms. Pollock requested that the word "and" be deleted.

But selection of new sites is moving at a snail's pace. And the large volumes of waste that [62] result from decommissioning are not yet a consideration in the decisionmaking process. Potential host States are wishfully thinking that decommissioning wastes will not become a problem until such time as the No. 2 State in the lineup becomes responsible for the region's waste.

In fact, large quantities of decommissioning wastes will require disposal during the operating life of the first round of sites; especially in the Northeast, the home of the Nation's oldest reactors.

In the United States approximately 70 nuclear reactors will require decommissioning within the next 25 years.

There are also a number of unknowns; probably the biggest unknown is how much it will cost to decommission reactors that are taken out of service. The only experience we have to date is with the Elk River facility in Minnesota, there was on 22 megawatt or one-fifth the size of large plants.[63]

Because our experience is so limited, cost estimates are highly speculative—they range from some $50 million to $3 billion per reactor. The latter figure equals the average cost of building them, on a U.S. facility.[64]

Until the mid-1970's many industry analysts believed that a utility would make money when it came time to decommission the plant. They believed that used equipment sales would bring in more money than demolition and disposal would cost. Today, those same analysts are projecting decommissioning costs of up to $.25 billion [65] dollars at current prices. Some outside analysts are projecting even higher costs.

Several factors will likely be responsible for keeping cost estimates on an upward trend. Low-level waste disposal fees, for example, have already risen tenfold in the last decade. And the problems inherent in establishing new facilities, particularly those with superior technologies and stricter regulations, will probably further increase costs.

Knowledge gained in many areas of decommissioning may also point to inadequacies in existing regulations and lead to more stringent and, therefore, more costly rules. In addition, economies of scale and the benefits of the learning curve may not be as great as anticipated. Radiation, especially that contributed by long-lived radionuclides, those have been proportioned [66] to the plant's capacity or size, multiplied by its operating life; thus, the larger the plant, and the longer it operates, the more radiation and long-lived radionuclides will be present.

Finally, since most reactors in the United States are basically custom-built, instead of the [67] standardized design, experience gained at one plant site may not be transferable to another. Additionally, since utilities must at this point wait to dispose of their facilities because of the lack of waste sites, they will not have the advantage that GE and the Department of Energy currently have at Shippingport, where Duquesne can pass on knowledge gained during the plant's operating life.

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[62] Ms. Pollock requested insertion of the word "will".

[63] Ms. Pollock noted that the sentence should read, "The only experience we have to date is with the Elk River facility in Minnesota, that was only 22 megawatts, or one-fiftieth the size of large plants, and operated for only four years."

[64] Ms. Pollock suggested the phrase should read ". . . building a modern U.S. facility."

[65] Ms. Pollock changed ". . . $.25 billion . . ." to ". . . a quarter of a billion . . ."

[66] Ms. Pollock changed this to read, ". . . radionuclides build up in proportion . . ."

[67] Ms. Pollock changed "the" to "a".

At Humboldt Bay, for example, the plant was taken out of service in 1976, but won't be dismantled until the year 2015, at which time it is likely that former employees will not be there to pass on advice.[68]

As we have heard, decommissioning the Shippingport reactor is expected to cost $98 million, or more than $1 million per megawatt, despite the unique transportation arrangement.

Now, I would like to look at the status of decommissioning regulations. In February 1985 the NRC first proposed decommissioning criteria for nuclear facilities; this action, though relatively late for utility planning purposes, is certainly a step in the right direction.

There are, however, some shortcomings in the proposed rules. I will briefly mention some of the most obvious.

The $100 million set-aside recommended by the NRC is not adequate, as we have heard a number of witnesses state today. In addition, entombment should not be permitted as a decommissioning option. Any protective structure would decay long before the radioactivity within.

Internal unsegregated decommissioning accounts should not be permitted as a savings mechanism. Ten States have already decided independently that external accounts managed by professional investors, and composed of diversified assets, provide much greater assurance that the funds will be available when required for decommissioning.

If insufficient money is collected from ratepayers during the years the plant produces power, or if the funds are not readily accessible when needed, future customers, shareholders, or taxpayers, will suffer the aftershock.

Of the four retired commercial reactors in the United States, only one unit had begun to build the decommissioning fund before it shut down. The Pacific Gas & Electric Co., owner of the Humboldt Bay reactor, collected $500,000 during the 4 years prior to plant closure. The amount is less than 1 percent of utility's decommissioning cost estimate.

Some of the unanswered questions that remain: Can a utility collect money for decommissioning from its customers and put it into an external trust fund on a tax deferred basis?

At present, money collected for decommissioning is considered utility income, subject to taxes in the year it is collected. So, in effect, only one-half of the money taken in is put into a decommissioning fund.

In 1984 the Internal Revenue Service proposed that utilities be able to set aside the full amount collected and postpone paying taxes until the money is used for decommissioning. The proposal has since been mired in tax reform,[69] leaving utilities and regulatory commissions unsure how to proceed.

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[68] Ms. Pollock changed the phrase to read, ". . . at which time it is unlikely that former employees will be there to pass on advice".

Mr. Garrett informs me that, with the recent tax reform bill, deferred accounts are now available to utilities but utilities will have to petition on an individual basis as to how much of the funds can be set aside on a tax-deferred basis. It is also unclear how much money will be set aside based on the number of years the plant operated before collecting money for decommissioning.

Another unanswered question is: How clean is clean? Residual radioactivity standards, defining the degree to which the reactor site must be cleaned up, have not yet been promulgated. Nor is it clear which waste would be considered contaminated and, thus, require special disposal, or which waste may be disposed of in common landfills or recycled.

In addition, the type of disposal required for transuranic waste is unclear. They are too radioactive to fit the definition for low-level waste, but they have not yet been classified as high-level. The additional cost that would be incurred if they were ultimately decided to require deep geologic disposal is substantial.

Resolution of these questions is imperative in order for utilities to plan both logistically and financially for decommissioning.

Another unanswered question revolves [70] the adequacy of existing technologies. According to some industry analysts, particularly those in Europe, the design of equipment for dismantling, especially remotely operated equipment, is in its infancy. The only real experience in the use of robotics and other advanced technologies is that gained in the effort to clean up Three Mile Island.

On the other hand, the dismantling of the Shippingport reactor is unlikely to add considerably to the industry's knowledge of dismantlement. As we have heard, DOE plans to save money by encasing the steel reactor vessel in concrete and transferring it intact to an oceangoing barge. But larger reactors may be too big to ship in one piece. And the most difficult task decommissioning crews of the future will face is dismantling the pressure vessel and its contents.

Full dismantlement of the Shippingport pressure vessel would provide a more valuable experience for the industry.

In sum, considerable progress is required before the industry will be adequately prepared to decommission the hundreds of reactors in service around the world. International cooperation through groups such as the International Atomic Energy Agency in Vienna, and the Nuclear Energy Agency in Paris, will help to quickly spread the lessons learned at the first decommissioning projects.

In the United States, unsettled regulatory issues regarding waste disposal, financing mechanisms and technological preparedness need to be addressed. Preparing to safely retire these plants requires aggressive, well-funded research and development programs, policy-makers willing to tackle unpleasant long-term problems, and robust retirement accounts funded by today's utility customers.

I would be happy to answer any of your questions.

[The report of Ms. Pollock follows:]

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[69] Ms. Pollock inserted the word "legislation".

[70] Ms. Pollock inserted the word "around".

Worldwatch Paper 69

Decommissioning: Nuclear Power's Missing Link

Cynthia Pollock

April 1986

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Introduction

5

Unprecedented construction cost overruns for nuclear power plants have halted growth in the nuclear industry in many countries. Even while staggering under these bloated costs, the industry is now faced with the expense of dismantling and disposing of worn-out reactors. Decommissioning—the process of cleaning up and burying a retired nuclear plant in order to protect the public from radioactivity—is an essential step in the use of nuclear power.

In most industries, the disposal of retired plant and equipment is a straightforward and relatively low-cost operation. But the high levels of radiation present in shutdown reactors will make the procedure uniquely complex and costly. Decommissioning will require remotely controlled technologies and large work crews to limit the exposure of individuals to radiation. Comprehensive strategies for transporting and disposing of radioactive wastes, and large amounts of readily available money will also be needed. The economic competitiveness of electric-generating technologies is traditionally judged by comparing construction and operating costs. But cost estimates for nuclear power will be meaningful only if a third variable, decommissioning costs, is incorporated into the equation.

Nearly four decades and 400 power plants into the nuclear age, the question of how to safely and economically dispose of nuclear reac-

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tors and their wastes is still largely unanswered. Nuclear plants cannot simply be abandoned at the end of their operating lives or demolished with a wrecking ball. Radioactivity builds up each year the plant operates, and all of the contaminated parts and equipment must be securely isolated from people and the environment. Some radioactive elements in plant components will decay quickly, but others will remain hazardous for millennia.

No one knows how much it will cost to decommission the hundreds of units in service and under construction around the world. Estimates range from $50 million to $3 billion per reactor.[1] The reactor construction binge prior to 1980 means that much of the decommissioning bill may fall due shortly after the turn of the century—from 2000 to 2020. Although engineers are attempting to lengthen the life expectancy of reactors, economical operation may not be feasible for longer than 30 years. Numerous technical difficulties, including the constraints radiation buildup places on routine maintenance and the inevitable embrittlement of the reactor pressure vessel, are likely to limit opportunities to extend plant life.

At the turn of the century, demand for new large-scale generating plants of all types is expected to be weak, particularly in the United States.[2] Thus nuclear decommissioning could be the largest expense facing the utility industry, outstripping plant construction. Given current policies, most of this bill will be paid by a generation that neither took part in the decision to build the first round of nuclear plants nor used much of the power generated.

Although nuclear power supplied 13 percent of the world's electricity in 1984, not a single large commercial unit has ever been dismantled.[3] Nuclear engineers have been attracted to the exciting challenge of developing and improving a new technology, not to figuring out how to manage its rubbish. But the problem will demand attention as a growing number of plants approach retirement age. Not one of the 26 countries currently relying on nuclear power is adequately prepared for this undertaking.

"Nuclear plants cannot simply be abandoned at the end of their operating lives or demolished with a wrecking ball."

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The oldest commercial nuclear reactors are already nearing the end of their useful lives, and some plants have closed prematurely because of accidents or faulty designs. In the United States, dozens of tiny research and military reactors are no longer used and four small retired commercial units are awaiting decommissioning. The U.S. Nuclear Regulatory Commission (NRC) estimates that another 67 large commercial units will cease operations before the year 2010. Worldwide, more than a dozen power reactors are already shut down, 66 more are likely to retire by the year 2000, and another 162 will reach their thirtieth year of operation in the following decade.[4] (See Table 1.) Countries with advanced nuclear programs will soon start to feel the pressure associated with managing the "back end" of nuclear power production.

The formidable issue of decommissioning is getting less attention than it deserves. Utility companies and ratepayers balk at yet another large expense associated with using nuclear power. And politicians are reluctant to tackle an issue that will not come to the forefront until after their political careers have ended. In many parts of the world, the nuclear power industry is strapped for cash and no longer commands the attention of scientists, business leaders, or policymakers.

Developing new technologies and formulating complicated regulatory guidelines for safely handling, transporting, and disposing of radioactive wastes will be difficult to accomplish in such a milieu. But there can be little argument that public health and safety and the financial solvency of utilities demand accelerated research on and financial planning for decommissioning.

Decontamination and Dismantlement

Following a nuclear plant's closure, the reactor owner must decide which of three courses to follow: decontaminate and dismantle the facility immediately after shutdown, put it in storage for several decades to undergo radioactive decay prior to dismantlement, or simply erect a "permanent" tomb. Each option involves removing the spent fuel, draining all liquids, and flushing the pipes.[5]

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Table 1: Nuclear Power Reactors in Operation and Under Construction Worldwide, 1956-95, and Year of Expected Retirement

Entered Service	Reactors	Capacity	Planned Retirement After 30 Years of Operation
	(number)	(megawatts)	
1956-60	13	780	1986-1990
1961-65	22	3,920	1991-1995
1966-70	31	10,831	1996-2000
1971-75	84	54,351	2001-2005
1976-80	78	61,476	2006-2010
1981-85	133	117,546	2011-2015
Cumulative in Operation	361	248,904	1986-2015
1986-90*	122	114,061	2016-2020
1991-95*	22	18,099	2021-2025
Total	505	381,064	

*Under construction or on order.

Source: "World List of Nuclear Power Plants," *Nuclear News*, February 1986.

Under the immediate dismantlement scenario, tubing and structural surfaces would be mechanically and chemically cleaned, a process called decontamination; irradiated steel and concrete would be disassembled using advanced scoring and cutting techniques; and all radioactive debris would be shipped to a burial ground. The site would then theoretically be available for unrestricted use.

Plants to be mothballed, on the other hand, would only undergo preliminary cleanup before being placed under surveillance. After 50 years in storage, most of the short-lived radioisotopes would have decayed, further safety gains would be negligible, and the facility would be dismantled. Entombment, the third option, entails covering the reactor with reinforced concrete and erecting barriers to keep out intruders. Although once viewed as the cheap and easy way out, entombment is no longer considered a realistic option because of the longevity of several radioisotopes. The protective structure would decay long before the radioactivity within.[6]

A survey of 30 electric utilities in the United States revealed that 22 planned to promptly dismantle and remove their reactors following shutdown. In Japan, utilities are advised to wait no longer than 10 years after closure to dismantle their plants. Utilities in Canada and France, on the other hand, plan to mothball most of their reactors for several decades before dismantling them.[7]

Regardless of the method chosen, decommissioning a large nuclear power plant is a complex task. The high levels of radiation present at recently closed reactors place numerous constraints on the decommissioning crew. Workers must take elaborate precautions, including wearing protective clothing and breathing apparatus, and limiting their time in contaminated environments. Radiation exposure must be carefully monitored, and according to industry standards kept "as low as reasonably achievable." Productivity will unavoidably be low, less than half of what it would be in a nonradioactive environment.[8]

Two sources of radiation will confront decommissioning workers—contaminated and activated materials. Contaminated parts include nearly all of the piping and equipment in the reactor containment vessel and the fuel, auxiliary, and control buildings. Many of the concrete surfaces in these buildings also become contaminated. The degree of contamination depends on the number of fuel leaks experienced during operation, the type of material exposed, and its exterior finish. Although high-pressure water jets and chemical decontaminants can wash off some surface contamination, only a fraction of the material becomes clean enough to recycle or dispose of in commercial landfills.[9]

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The volume of solvents used must be carefully regulated because they too become contaminated. Spills during either operation or cleanup can result in contamination of the surrounding soil. Keeping waste volumes to a minimum is an elusive goal: Each piece of machinery and every tool that comes into direct contact with a contaminated surface must be decontaminated or added to the radioactive waste pile.

The other source of radiation that will confront decommissioning crews is "activation" products. When nuclear fuel undergoes fission—the splitting of uranium atoms—stray neutrons escape. These neutrons bombard the nuclei of surrounding atoms, and the resulting change in composition causes some trace elements in the steel and concrete that encircle the reactor core to become radioactive. Neutron-activated parts include the reactor pressure vessel, the vessel's internal components and structures, and the surrounding concrete shield. Neutron-activated components are more than 1,000 times as radioactive as contaminated components, and because they are composed of radioisotopes they cannot simply be washed clean.[10]

Estimating the volume and radioactivity of activation products that will be encountered at a retired reactor is difficult. The complex arrangement of the components in and around the reactor core makes it hard to predict the movement of neutrons. Accurate assessments of the quantity of activation products also require a detailed knowledge of the amounts of various elements that are present in the construction materials, sometimes at the parts per million or even parts per billion level. Studies conducted in France showed only a small variation in the composition of concrete used in the European Community's reactors, but studies of reactor construction materials in the United States showed greater variability. Cobalt and niobium concentrations in stainless steel were found to vary more than tenfold.[11]

For the first several decades following plant shutdown, the most problematic elements are those that decay the fastest. Cobalt and cesium are the dominant short-lived radioisotopes, with half-lives (the time it takes radioisotopes to lose half their radioactivity) of five and 30 years respectively. Other elements with longer half-lives are

"Practical decommissioning experience is limited to very small reactors."

present in smaller quantities and will dominate radiation levels in the future. Neutron-activated materials contain significant amounts of long-lived nickel and niobium radioisotopes. Nickel 59, for example, has a half-life of 80,000 years.[12]

Following preliminary decontamination, the structures surrounding the reactor must be cut into smaller pieces for transportation and burial. A steel pressure vessel containing a 1,000-megawatt reactor is typically over 12 meters high and 4 meters in diameter. The concrete vessel surrounding an advanced gas reactor, the type used in the United Kingdom, is several meters thick. Dismantling the vessels is both complicated and hazardous. Each cut causes more airborne contamination, so remote-controlled equipment will probably be used to keep worker exposure to a minimum. Although testing of several dismantling techniques is underway, more research is required to prepare the industry for dismantling today's large reactors. According to Dr. Paul Woollam, a member of the Commission of the European Communities team that in 1984 conducted a comprehensive analysis of decommissioning capabilities, "The design of equipment for dismantling, especially remote equipment, is in its infancy."[13]

Practical decommissioning experience is limited to very small reactors. The tiny 22-megawatt Elk River plant is the largest that has been fully decontaminated and dismantled. The U.S. Department of Energy (DOE) completed this three-year project in 1974 at a cost of $6.15 million. The plant had only been in operation for four years. Plasma arc torches were used to cut apart the reactor, and 3,630 cubic meters of contaminated materials were buried. Many modern reactors can produce 50 times more power and will have operated some seven times as long as Elk River. Since radiation builds up in proportion to plant size and operating life, a 1,000-megawatt reactor used for 30 years would pose considerably more problems.[14]

Twenty-five miles outside of Pittsburgh, Pennsylvania, DOE is currently decommissioning the United States' first commercial reactor. The 72-megawatt Shippingport plant began producing electricity in 1957, and after 25 years of operation, it was closed in 1982. In accordance with the original contract, the U.S. government is responsible

for decommissioning the plant. Shippingport will be the largest unit
decommissioned to date anywhere in the world and it could be used
12 as a valuable and badly needed prototype.[15]

Instead of seizing this learning opportunity, DOE plans to encase the 10-meter-high steel reactor vessel in concrete, transfer the 770-ton behemoth intact to a 4,000-ton barge, and send it down the Ohio and Mississippi rivers, through the Gulf of Mexico and the Panama Canal, and up the Pacific Coast and Columbia River. It is to be buried in an earthen trench on the government-run Hanford nuclear reservation. Keeping the Shippingport reactor pressure vessel in one piece instead of chopping it up and sending it by truck is estimated to lop at least $7 million, or 7 percent, off the total price tag.[16]

This action is shortsighted. By employing cost-cutting measures now, DOE is depriving the international nuclear industry—the same one it helped foster—of invaluable lessons. Larger reactors may be too big to ship in one piece, and the most difficult task decommissioning crews of the future will face is dismantling the pressure vessel and its contents.[17]

In Europe, efforts to decommission several commercial reactors are just getting underway. The first three projects will be the 100-megawatt Niederaichbach unit in West Germany, the 33-megawatt Windscale advanced gas reactor in the United Kingdom, and the 45-megawatt French G-2 gas reactor at Marcoule. Although the French and U.K. plants are small, each operated for about 20 years—long enough to become well contaminated. The larger, German reactor was in service for only two years before technical difficulties resulted in its closure. Each unit has a different design, and dismantling efforts are likely to uncover problems unique to specific technologies.[18]

However, experience gained at the damaged reactor at Three Mile Island will aid future decommissioning work. The industry's knowledge of robotics, chemical decontaminants, and remote cutting techniques has greatly expanded as a result of the cleanup effort.

> **"By employing cost-cutting measures now, DOE is depriving the international nuclear industry—the same one it helped foster—of invaluable lessons."**

International information sharing and on-site observations by foreign experts mean that these lessons may be widely applied.[19]

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The overriding consideration in selecting a decommissioning schedule and the appropriate decontamination and dismantlement methods must be worker and public safety. Although radioactivity declines more than twentyfold during the first 30 years of storage, governments and the public may not be willing to tolerate the presence of these highly radioactive structures, or be willing to face the charge of "passing the buck" to future generations. The Humboldt Bay reactor on the northern California coast has been the center of controversy since its retirement in 1976. The unit lies in a seismically active zone and is not structurally engineered to withstand earthquakes—which is why it was permanently taken out of operation. Immediate dismantlement would make the site available for other uses, and would safeguard the public against potential exposure to radiation. Yet efforts to dismantle the plant are not expected until after the year 2000.[20]

High-Level Waste Management

Discussions about decommissioning typically exclude the topic of high-level nuclear waste disposal. But high-level wastes—spent fuel and the byproducts of fuel reprocessing—must be removed from the plant before decommissioning can proceed. At present, not a single country has a permanent disposal facility for high-level wastes and no such facilities are likely to be in operation before the turn of the century.

The fuel for most nuclear power plants consists of small pellets of uranium oxide—the size of pencil erasers—that are sealed in 12-foot-long metal tubes and bundled into fuel assemblies. Fission products that result from the splitting of uranium atoms gradually build up to a point that inhibits the chain reaction. One fourth to one third of the fuel in a typical reactor must be replaced each year. The spent fuel is highly radioactive and consequently very warm. Spent fuel remains more radioactive than the original uranium ore for about 3 million years. Remote handling conducted behind heavy shielding is essential.[21]

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Until the mid-seventies the international nuclear industry assumed that reprocessing of spent fuel would become a universal practice, providing fuel for the next generation of breeder reactors and a means of quickly removing the spent fuel from utility holding ponds. But along with uranium, fuel reprocessing recovers plutonium, which can be readily made into nuclear bombs. Concerns about nuclear proliferation, coupled with new discoveries of uranium, a slowdown in reactor construction, and the demise of most breeder programs, undercut the rationale for reprocessing in many countries. The U.S. program was abandoned and today only France, the Soviet Union, and the United Kingdom have sizeable reprocessing industries.

Seven European nations and Japan have contracted to send at least a portion of their spent fuel to the British Sellafield reprocessing plant or the French Marcoule and La Hague facilities. The recovered uranium and plutonium, and the high-level wastes that are typically stabilized in glass cylinders, are to be returned to the countries of origin. Therefore, although sending spent fuel abroad for reprocessing temporarily eases the waste management problem, it does not permanently eliminate the need for sound handling and disposal policies. Indeed, reprocessing compounds the handling problem because it increases the number of times the fuel is manipulated and transported. Because reprocessing is more expensive than direct disposal, customers are essentially buying time to decide on a permanent disposal strategy.[22]

In the United States, virtually all of the 12,000 metric tons of spent fuel produced to date is now stored temporarily in water-filled utility holding ponds. The volume of waste is expected to quadruple within 15 years. Utilities do not have adequate space for storing this spent fuel, nor is there anyplace they can send it.[23] For years, the nuclear industry ignored the issue of permanent high-level waste disposal, thinking reprocessing would relieve it of the burden. Today the disposal problem, though managed by national energy agencies, is back

"The toxicity of high-level wastes requires that they be kept out of the biosphere for tens of thousands of years—longer than recorded history."

in their laps. It is impossible to fully dismantle a nuclear plant if there is nowhere to put the spent fuel cooling in utility storage ponds.

People exposed to large doses of radiation may become ill or die within several weeks. Exposure to lower doses results in long-term effects, including several types of cancer. And children whose parents were exposed are prone to genetic mutations and birth defects. Some radioisotopes are especially dangerous if they are ingested or inhaled because they mimic essential nutrients, concentrate in vulnerable organs, and then decay inside the body. Radioactive strontium and cesium, for example, behave like calcium and accumulate in bones. And unlike many chemicals, radioactive waste cannot readily be detoxified or destroyed. Health risks can only be avoided by keeping wastes out of the biosphere until they have decayed to harmless levels.[24]

Where to dispose of high-level wastes has become a contentious political issue in each of the 26 countries that produce nuclear power. Few national governments have been in power for more than several decades, and the lifespan of most energy agencies is even shorter. But the toxicity of high-level wastes requires that they be kept out of the biosphere for tens of thousands of years—longer than recorded history.

Since reliance on human institutions for such a long period of time is impossible, most countries have decided to bury their wastes in geologic repositories 300 to 1,200 meters below the earth's surface. Searching for stable sites is the current focus of most disposal programs. The characteristics of a good site include unfractured geology so groundwater will not migrate through the area and contaminate water supplies, low seismic activity, and the absence of mineral wealth so future generations will not find the area attractive for drilling.

Political opposition to high-level waste disposal will be at least as difficult an obstacle as finding a geologically appropriate site. Winning public acceptance is likely to be particularly tough where population densities are high, such as in Japan and Europe. Some countries—the Netherlands, for example, where there is strong public opposition to all forms of waste disposal—are hoping that international sites will become available, perhaps operated by reactor suppliers. Yet no nation would likely want to accept large volumes of imported waste. China offered to store a small portion of West Germany's spent fuel, but the contract was linked to China's obtaining a bargain price on two reactor orders. Now that the Chinese have cut back their nuclear program, the offer may no longer be good. The Soviet Union is the only country that takes back the high-level wastes generated by the reactors it sells, most of them to Eastern European nations.[25]

The geologic medium chosen for a permanent repository is likely to be limited by the options available domestically. Sweden plans to dispose of its high-level wastes in granite, West Germany is examining the use of salt mines, and Belgium hopes to place its waste in clay. (See Table 2.) Japan is considering several rock types, but the country is so earthquake-prone that none may offer adequate stability. At this time, no single geological formation is considered substantially superior. Problems have been found with each.

Most European nations are just beginning to seriously explore and evaluate permanent disposal sites. West Germany hopes to dispose of its high-level wastes in the Gorleben salt dome and has begun construction of exploratory shafts. The Stripa mine in Sweden has been the focus of international research for almost a decade, but Sweden plans to develop a new granite repository 500 meters below the earth's surface. Construction is not scheduled until the year 2010, when all of the nation's 12 reactors will be taken out of service. The United Kingdom has explicitly deferred the decision to proceed with repository siting and France appears content to rely indefinitely on "temporary" storage at its reprocessing facilities.[26]

Several experimental high-level waste repositories have already been tested in the United States, but none has proved acceptable. In 1982 the U.S. Congress passed the Nuclear Waste Policy Act (NWPA), requiring the federal government to develop two permanent mined geologic repositories and have the first ready for business by 1998.

Table 2: Geologic Media Selected for Further Study as High-Level Waste or Spent Fuel Repository in Various Countries

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Country	Granite	Clay	Salt	Basalt	Tuff	Shale	Diabase
Belgium		X					
Canada	X						
France	X	X	X				
Japan	X				X	X	X
Spain	X		X				
Sweden	X						
Switzerland	X						
United Kingdom	X						
United States	X		X	X	X		
West Germany			X				

Source: K. M. Harmon, "Survey of Foreign Terminal Radioactive Waste Storage Programs," in *Proceedings of the 1983 Civilian Radioactive Waste Management Information Meeting*, Washington, D.C., December 12-15, 1983 (Springfield, Va.: National Technical Information Service, 1984).

The Environmental Protection Agency issued standards prohibiting radiation releases from the 300- to 1,200-meter-deep burial sites for 10,000 years. The location of the first repository has been tentatively narrowed to one of three sites: Hanford, Washington; Yucca Mountain, Nevada; or Deaf Smith County, Texas.[27]

Final site selection has already become a political hot potato. Potential host states and environmental groups have filed lawsuits challenging the adequacy of the siting guidelines. According to James Martin, a staff attorney with the Environmental Defense Fund: "First, there are concerns that, in its haste to site a repository, [the Department of Energy] has relied on pre-NWPA studies of dubious quality and is delaying analysis of waste transportation risks that cannot be deferred. Second, there is evidence that politics are creeping into and tainting the decision-making process. These factors pose grave threats to the integrity and public acceptance of the siting process."[28]

Each of the proposed sites has drawbacks. There is much concern, for
example, that disposal at Hanford could lead to contamination of the
18 nearby Columbia River. And farmers in Texas fear contamination of
the aquifer they use to irrigate their crops. Choosing the best site will
unquestionably be difficult, but the only way to inspire confidence in
the final choice is to conduct extensive testing at each proposed
location and make the results available for scientific review.

Several nations are examining intermediate storage of spent fuel at centralized locations away from reactor sites. Sweden has the most advanced program: Its CLAB facility, adjacent to the Oskarshamn power station, will hold spent fuel from all Swedish reactors in artificial underground ponds for several decades prior to geologic disposal. A half-dozen countries are experimenting with dry spent fuel storage as an interim step between utility holding ponds and permanent disposal. Aboveground concrete silos and reinforced concrete vaults are already available in Canada, the United Kingdom, and West Germany.[29]

In the United States, three sites in Tennessee, including the abandoned Clinch River breeder reactor, are being considered as hosts for a retrievable storage program. Though presently blocked by the courts, the storage plan would allow DOE to fulfill its obligation to take possession of commercial spent fuel in 1998 even if a permanent geologic repository is not yet available. Storing the fuel allows further radioactive decay which would result in a cooler—and therefore safer—waste package. But a centralized storage system would also significantly increase the number of times fuel must be handled and transported. Critics fear the strategy is being promoted because DOE will not meet its deadline for establishing permanent repositories.[30]

In 1976, the California legislature was the first to enact a bill forbidding further nuclear power plant construction until "the federal government has approved, and there exists, a demonstrated technology or means for the disposal of high-level nuclear wastes." Without such assurance, it is impossible to fully assess the costs of nuclear power. Controversial at the time, the measure was only one of the

"The present inability to dispose of high-level wastes is causing many developing countries to shy away from building nuclear power plants."

many factors that put an end to reactor orders in the United States. The deteriorating economics of nuclear power, low electricity-demand growth, and tightened regulation after the accident at Three Mile Island are considered the principal reasons that no new reactors have been ordered since 1978.[31] 19

"Stipulation" laws making continued use or construction of nuclear power facilities contingent upon the development of satisfactory plans for managing the spent fuel and reactor wastes have also been enacted in Belgium, Finland, the Netherlands, Sweden, Switzerland, and West Germany. Though Japan has similar regulations in place, one commentator likens its lack of high-level waste disposal facilities to "living in a house without a toilet." According to the International Atomic Energy Agency in Geneva, the present inability to dispose of high-level wastes is causing many developing countries to shy away from building nuclear power plants.[32]

The Nuclear Energy Agency in Paris projects that nearly 160,000 metric tons of spent fuel will have accumulated in countries belonging to the Organisation of Economic Co-operation and Development (OECD) by the year 2000.[33] Existing utility holding ponds are not large enough to accommodate this increase, nascent away-from-reactor storage techniques are unlikely to be sufficiently developed, and permanent repositories will probably be stalled by political and technical obstacles.

If there is no place to which the spent fuel can be shipped, mothballing will, by default, become the only feasible decommissioning strategy. Choosing the safest and least expensive decommissioning schedule is only possible if high-level waste disposal facilities exist. In countries where fuel is not reprocessed or shipped to central storage facilities (and thus removed from the reactor site), the lack of permanent repositories could severely limit opportunities for timely decommissioning.

Disposal of a Retired Reactor

20 Removing the spent fuel is only the beginning of the decommissioning process. Few nations have independent commercial disposal facilities for low-level radioactive wastes, a much larger category that encompasses everything from work gloves and used equipment to contaminated water and soil. Although this waste is considerably less toxic than spent fuel and reprocessing wastes, it is produced in far greater volumes. The largest contributor of low-level waste is nuclear power generation, but hospitals, medical laboratories, and a variety of industries also produce substantial quantities. Most low-level wastes decay to safe levels in several decades, but some remain dangerous for hundreds of years.

An average pressurized water reactor, the most commonly used nuclear technology, sends about 400 cubic meters of low-level wastes to burial sites each year. When the reactors are dismantled, they will each produce an estimated 18,000 cubic meters of low-level waste, half again as much as will have been generated throughout the unit's operating life. (See Table 3.) This is enough to bury a football field under four meters of radioactive debris. Decommissioning just one large reactor would yield a volume of contaminated concrete and steel equal to one fourth of the low-level radioactive wastes now shipped to all U.S. commercial dumpsites in a year.[34]

Until 1970, the United States and many other nations discarded low-level wastes by dumping them at sea. Belgium, Japan, the Netherlands, Switzerland, and the United Kingdom were still dumping much of their low-level waste until 1983, when the London Dumping Convention declared a moratorium pending a scientific study of the effect on the marine environment. The reprocessing operation at Sellafield, however, still pumps 1.2 million gallons of slightly radioactive wastewater into the ocean daily.[35]

On-land disposal typically involves packing the debris in barrels and storing them either at the reactor site or in specially designated warehouses. Canada and Japan, each operating large nuclear programs,

Table 3: Estimated Low-Level Radioactive Wastes from Dismantlement of a Typical 1,100-Megawatt Pressurized Water Reactor

Material	Burial Volume	Truckloads
	(cubic meters)	(number)
Activated		216
Metal	484	
Concrete	707	
Contaminated		967
Metal	5,465	
Concrete	10,613	
Radioactive	618	180
Total	17,887	1,363

Source: R. I. Smith, G. J. Konzek, and W. E. Kennedy, Jr., *Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station* (Washington, D.C.: U.S. Nuclear Regulatory Commission, 1978).

practice this approach. In only some half-dozen countries are the drums transported to commercial low-level waste depositories and buried in earthen, or more recently concrete-lined, trenches.[36]

Experience with traditional shallow land burial has been mixed. Three low-level waste sites in the United States, each opened during the sixties, have subsequently been closed because poor burial practices resulted in surface water infiltration and contamination. Kentucky, Illinois, and New York, the states in which the contaminated trenches are located, each spend millions of dollars annually to clean and monitor the sites. By the late seventies only half of the country's low-level waste sites were still operating—one each in Nevada, South Carolina, and Washington. Objecting to their role as the nation's dumping ground, the three state governments closed or restricted access to their facilities for a short time in 1979.[37]

22 This prompted the U.S. Congress to pass the Low-Level Radioactive Waste Policy Act in 1980. The law made each state responsible for managing the commercial low-level waste generated within its borders, and encouraged states to form regional agreements to establish and operate disposal facilities cooperatively. The new waste sites were supposed to be operational by New Year's Day 1986. When it became obvious that the deadline would not be met and that half the low-level waste produced in the United States, accounting for nearly three quarters of the radioactivity, would be barred from the nation's waste sites, an eleventh-hour compromise was reached. Slow-acting states were given a seven-year extension and the first seven "regional compacts," involving 38 states were approved.[38]

But the governors of Nevada, South Carolina, and Washington drove a hard bargain. They set limits on the volume of waste their sites will accept each year and developed quotas for individual reactors in various regions. Total volume reduction required per reactor ranges from 18 to 45 percent. In the future all wastes accepted from outside these three regions will be assessed a surcharge rising from $10 per cubic foot in 1986 (a 30 percent increase over present rates) to $40 per cubic foot in 1990. If interim deadlines are met, one quarter of the surcharge fees will be returned to the state of origin to help offset the costs of establishing new waste facilities.[39]

Selecting new burial sites promises to be difficult. Maine, Massachusetts, and South Dakota already require voter approval of either compact or siting decisions. And both Nevada and South Carolina have stipulated that their disposal sites will soon close and other states in their respective regions will have to accept wastes in the future. Political opposition to nuclear waste sites is strong and past operating experience has done little to dispel public concerns.[40]

Because several of the first sites developed leaks, at least five states—Illinois, Kentucky, Massachusetts, Pennsylvania, and Texas—have prohibited the future use of traditional shallow land burial. They may still allow underground waste disposal, but they will require engineered barriers such as concrete-lined trenches, and strict en-

"Political opposition to nuclear waste sites is strong and past operating experience has done little to dispel public concerns."

forcement of packaging regulations. Other disposal techniques seriously being studied include aboveground vaults, earth-mounded concrete bunkers, mined cavities, and augured holes. To date these technologies have been used primarily for waste storage, not disposal, and there is concern about their long-term ability to isolate wastes. Aboveground structures, for example, will be subject to natural catastrophes, possible intrusion, and years of weathering.[41]

Many states are examining new disposal methods, but for the most part they are inexperienced in dealing with low-level wastes and have limited budgets. Congress has made the states responsible for the wastes generated within their borders, but no federal funds have been allocated for assistance, and the two organizations with the most expertise, the NRC and DOE, do not plan to conduct additional research and development activities. Their role will be purely advisory. Despite the desire to build safer disposal sites, most states are ill-equipped to meet the challenge and fear that proposals to use alternative methods will result in regulatory delays.[42]

Since systems with elaborate safeguards are expensive to build and operate, states have been encouraged to join forces to designate regional sites at which high management standards can be enforced. Such regional facilities would certainly be safer than periodically rotating sites among member states, a dangerous alternative that nevertheless is sometimes endorsed for political reasons. New waste sites are only expected to operate for 20 to 30 years before they are closed and a new regional site is required. Disposal responsibility is thus likely to rotate among a regional compact's member states eventually and there is no need to accelerate the process.[43]

In Europe, several different approaches to low-level waste disposal are being examined. Sweden plans to dispose of its waste in numerous galleries and chambers sunk into granite rock 50 meters below the Baltic Sea. An abandoned iron mine has been designated as a future disposal site in West Germany, but in the meantime, wastes are temporarily stored in aboveground warehouses. Japanese nuclear plants store low-level wastes on-site. Incinerators and compactors keep waste volumes manageable while research is conducted on both land and sea disposal.[44]

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In France, low-level wastes have been disposed of in earth-mounded concrete bunkers at the La Manche center since 1969. The success of the facility has prompted the Westinghouse Electric Corporation to develop a disposal system, called "SAVEPAK," patterned after the French method. Incoming wastes would first be X-rayed to make sure they are liquid-free and to measure their level of radioactivity. Compactors would then squash many of the drums to one-seventh their original size. All the wastes would be placed in concrete monoliths and then buried in huge graves. Several regional compacts in the United States, along with utilities in Japan, Spain, South Korea, and the United Kingdom, have expressed interest in adopting the technology.[45]

All the contaminated and activated components of a reactor require special handling and disposal, but a small percentage of the wastes are considered too radioactive to be classified as low-level. Transuranic wastes, those containing elements heavier than uranium, are all formed as activation products. They have long half-lives and require isolation from the biological environment for many thousands of years. Until recently, transuranics were disposed of the same way as low-level wastes. They are now stored at reactor and reprocessing sites and commonly referred to as "orphan wastes." Their long half-lives make them too dangerous for shallow land burial, but governments have been reluctant to assume responsibility for them as part of national high-level waste programs. Eventually, they will probably be disposed of in geologic repositories.[46]

Plans for developing new low-level waste sites do not address the need to provide adequate capacity for decommissioning wastes. Regulations do not specify a minimum size and it appears that the second generation of disposal sites may only be large enough to accept annual operating wastes. If this occurs, decommissioning activities may be hindered by the lack of both high- and low-level waste disposal facilities.

"Decommissioning policy is held hostage to the lack of disposal sites."

Most nations that have decided to use nuclear power have shirked the responsibility of safely managing radioactive wastes. In 1981, the Atomic Industrial Forum, an industry trade group, observed that "Because of the present waste disposal problem, it may not be possible to conduct a total decommissioning today. Therefore, the options a utility can choose at the present time are mothballing or entombment with onsite storage of all active material."[47] That statement is still true today. Decommissioning policy is held hostage to the lack of disposal sites.

Estimating the Costs

The cost of decommissioning nuclear power reactors is highly speculative. Cost estimates have been derived from generic studies, from scaling up the costs of decommissioning smaller research facilities, from calculations based on a fixed percentage of construction costs, and more recently from site-specific engineering studies. The detail and sophistication employed in developing these estimates varies greatly and their lack of standardization makes comparisons difficult. Moreover, limited decommissioning experience—none with large reactors—makes it impossible to know if the estimates are on target. In effect, all the figures put forward are guesses based on numerous uncertain assumptions and varying degrees of wishful thinking.

In 1978 the U.S. Nuclear Regulatory Commission asked the Battelle Pacific Northwest Laboratory to estimate the cost of decommissioning a generic 1,175-megawatt pressurized water reactor (PWR). A Battelle study conducted two years later estimated the cost of decommissioning a boiling water reactor (BWR). These are the two most commonly used nuclear technologies in the world, accounting for 72 percent of all operating reactors—165 PWRs and 77 BWRs. Battelle concluded that costs would depend primarily on the reactor design and the number of years after shutdown that dismantlement would be deferred. In general, more plant components become contaminated in boiling water reactors so they require a larger labor force, produce a greater volume of low-level wastes, and consequently are more expensive to decommission. For both designs, immediate dismantlement was considered slightly less expensive than storage, in spite of higher initial costs.[48]

26 The Battelle figures were widely adopted within the utility industry and used as a proxy by many companies that had not developed their own estimates. But the studies were never intended to be used in this way. They were meant to be used as guidelines, and to give utilities and their regulators a ballpark estimate of the decommissioning costs they were likely to encounter. Differences in plant size and design, operating history, future availability of and distance from waste disposal facilities, regional variations in labor rates, and unique site characteristics such as space limitations were largely ignored. As individual utilities began to conduct their own site-specific cost estimates, and as various component costs such as waste disposal rose much faster than anticipated, it became obvious that the initial estimates were too low.

In 1984, Battelle updated its studies, this time for the Electric Power Research Institute, and costs had indeed risen much faster than inflation over the preceding six years. Waste disposal costs rose the fastest. Assumptions were also modified to reflect current regulations and market conditions. For example, when the original PWR analysis was performed, it was assumed that decommissioning workers could be exposed to four times as much radiation during a one-year period as was subsequently deemed safe.[49]

The projected price tag for immediate dismantlement of a 1,175-megawatt PWR, using outside contractors, rose to $104 million and for a 1,155-megawatt BWR to $133 million. Comparative site-specific, rather than generic, estimates for two 1,100-megawatt reactors produced estimates of $140 million for a PWR (35 percent higher than the updated Battelle estimate) and $134 million for a BWR, excluding the costs of removing nonradioactive structures.[50]

Estimates derived from scaling up costs based on the experience at smaller, less contaminated facilities, and from assuming a fixed percentage of construction expenditures are even higher. California regulators have assumed in some studies that decommissioning expenses would be 10 percent of capital investment. A detailed three-year study of decommissioning costs in Switzerland concluded that retiring a nuclear plant would cost one fifth as much as the facility originally cost to build. After evaluating decommissioning experiences at Elk River and a smaller research reactor, Peter Skinner, a state-hired engineer, advised the New York Public Service Commission that decommissioning could potentially cost 24 percent of original construction costs. This translates to more than $500 million for most recently completed U.S. reactors.[51]

André Crégut of the French Atomic Energy Commission believes that utilities will not begin to decommission their reactors until costs can be brought down to 15 percent of the original investment. He estimates that using currently available techniques, the cost of decommissioning would be at least 40 percent of the cost to build.[52]

All of these projections assume normal reactor operating conditions. Economist Duane Chapman at Cornell University has observed that the Three Mile Island plant is so heavily contaminated that dismantlement may exceed the original cost. Although the level of contamination at Three Mile Island is many times higher than will be encountered at most power reactors, cleanup costs there are projected to pass $1 billion before decommissioning itself is contemplated. Chapman has also predicted that dismantlement might cost as much as reactor construction, in constant dollars, at plants where accidents have not occurred. In the United States, this amounts to an average of about $3 billion for a new 1,000-megawatt unit. Chapman expects that as decommissioning cost estimates rise, utilities will forgo immediate dismantlement and instead favor storage or entombment.[53]

Research done at the Rand Corporation reinforces Chapman's skepticism. Analysts there have concluded that large-scale engineering projects based on newly developed technologies cost on average four times more than initial estimates. Recent U.S. nuclear power plant construction costs total 5 to 10 times original projections, even after accounting for inflation.[54]

28 Because of gross cost overruns, approximately $20 billion worth of partially constructed nuclear plants have been abandoned in the United States. In the early seventies, reactors were expected to come into service at well under $1 million per megawatt. Costs for just-completed units now average closer to $3 million per megawatt, and at the not-yet-operating Shoreham plant on Long Island, the figure has already surpassed $5 million per megawatt.[55] Decommissioning estimates put forward by the nuclear industry presume that as experience is gained, costs will fall over time. But U.S. nuclear construction experience appears to defy the learning curve—costs rose over the years.

Members of the Atomic Industrial Forum have recently completed "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates." The guidelines attempt to standardize cost estimates and eliminate past deficiencies so estimates can be readily compared and understood by analysts and members of regulatory commissions. According to the authors, Williams and LaGuardia, "It is of equal importance to identify all assumptions used in the estimate. One of the major problems associated with attempting to compare the costs to decommission units estimated by different parties is to account for the different assumptions made. Unless they are clearly identified, no rational comparison can be made." In the past, some estimates included the expense of removing spent fuel, others the cost of demolishing nonradioactive structures, and still others the cost of long-term surveillance and security at a mothballed plant. Some utilities included costs attributable to complying with stricter regulations governing waste disposal and worker exposure limits while others did not. Rarely were the costs, expense categories, or assumptions comparable from one study to another.[56]

Several site-specific cost estimates that rely on the recently developed guidelines are now complete. For BWRs in the 1,100- to 1,200-megawatt range, these studies estimate the cost to remove and dispose of radioactive structures and waste at between $120 and $170 million.[57]

In Japan, a policy advisory group for the Agency of Natural Resources and Energy studied the costs of and optimal schedule for de-

"Financial compensation may be required to entice communities to accept radioactive waste."

commissioning. It concluded that dismantling a 1,100-megawatt plant after five years of storage will cost $160 million.[58]

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The major expenses associated with decommissioning are the packaging, transportation, and burial of wastes; labor; energy; demolition; and equipment. In several site-specific cost estimates, waste disposal accounted for 40 percent of the total. In the last decade, the cost of shallow land burial of a 55-gallon drum of low-level wastes has increased more than tenfold in the United States. And, as discussed in the previous section, new low-level burial grounds will be technologically superior to and more strictly regulated than past sites. The unique problems inherent in establishing new facilities—for both high- and low-level wastes—will further raise disposal costs.[59]

Financial compensation may be required to entice communities to accept radioactive wastes. The United Kingdom is seriously reevaluating its disposal-facility siting policies following vehement local opposition to a plan for using an abandoned salt mine at Billingham in northeast England. Lewis Roberts, director of the Atomic Energy Research Establishment at Harwell, recently acknowledged that the agency may have to adopt the French and Japanese practice of compensating communities for hosting repositories.[60]

Reactor dismantlement is a labor-intensive process. A survey of 21 cost estimates, for both pressurized and boiling water reactors, found that labor expenses were forecast to contribute from between 25 and 50 percent of total costs. Following two years of planning and preparation prior to shutdown, disassembling a large PWR is expected to require more than 300 worker-years. Additional workers will be required to decontaminate and dismantle the cooling systems in boiling water reactors. Permissible radiation exposure levels have become progressively stricter over the years and may continue to tighten in the future because the health effects of long-term exposure to low levels of radiation are still debated by medical professionals. Replacement of steam generators at the Surry reactor in Virginia required more than three times as many worker-hours as anticipated in order to keep down exposure levels.[61]

30 Decommissioning cost estimates for two of the reactors that will be among the first to be decommissioned amount to more than $1 million per megawatt. (See Table 4.) The Shippingport facility, despite its unique transportation arrangement and federally subsidized waste disposal, is expected to cost $98 million to decommission—$1.36 million per megawatt. This figure excludes the cost of dismantling noncontaminated buildings. Shippingport is also considerably less contaminated than larger reactors will be, not only because it is small,

Table 4: Estimated Decommissioning Costs for Nuclear Power Plants No Longer in Operation

Owner/Site	Capacity	Estimated Decommissioning Costs	Cost Per Megawatt	Years Operated
	(megawatts)	(millions of 1985 dollars)		
U.S. Atomic Energy Commission, Elk River	22	14[1]	0.58	1964-68
U.K. Atomic Energy Authority, Windscale	33	64	1.94	1962-81
Pacific Gas and Electric, Humboldt Bay-Unit 3	65	55	0.85	1963-76
U.S. Department of Energy, Shippingport	72	98	1.36	1957-82
Commonwealth Edison Co., Dresden-1	210	95	0.45	1960-78

[1] Decommissioning of Elk River was completed in 1974.

Sources: R. Mark Pocta, "Report on the Decommissioning Costs of Pacific, Gas and Electric Company for Humboldt Bay Power Plant Unit No. 3," California Public Utilities Commission, June 1985; OECD Nuclear Energy Agency, "Compendium on Decommissioning Activities in NEA Member Countries," Paris, January 1985; "DOE Says Decommissioning Costs on Target Despite Shippingport Increase," *Nucleonics Week*, April 25, 1985; Public Citizen/Environmental Action, "Dismantling the Myths About Nuclear Decommissioning," Washington, D.C., April 1985.

"Because of the variety of reactor types in operation, decommissioning costs and experience may not be transferable among utilities."

but because it has already been thoroughly decontaminated once during its operating life and has had several reactor cores.[62]

Although members of the nuclear industry expect that economies of scale will make decommissioning larger reactors proportionally cheaper, the amount of radiation that builds up in a plant, especially that contributed by long-lived radioisotopes, depends on the power output of the reactor multiplied by the number of years it operates. The larger the plant, the greater the cleanup and disposal effort it will require.

Because reactor designs have changed so much over the years, very few countries will be able to develop specific decommissioning plans applicable to more than several reactors. Not only have different countries adopted different reactor technologies, but within some nations the nuclear industry has dabbled in most of the systems available. France, Canada, and perhaps the Soviet Union are the only major nuclear countries that have achieved a high degree of uniformity in their construction programs. These nations also commonly build four to eight reactors at each plant, a strategy that should help to hold down decommissioning costs. The United States and Japan typically build only two to three reactors at one site. The 17 shutdown power reactors listed in Table 5 represent eight different designs. Nuclear construction costs steadily rose in the United States in part because each utility built a custom-designed plant. Because of the variety of reactor types in operation, decommissioning costs and experience may not be transferable among utilities.[63]

There are vast uncertainties associated with trying to estimate costs 30 to 100 years in the future. Assumptions must be made about the evolution of technologies and the likely increase in decommissioning costs, inflation, and real interest rates. Estimates must also include provisions for stricter government regulations and other unforeseeable events. The staff most familiar with the plant will have left the company and excellent recordkeeping will be required to inform the future crew of the reactor's intricacies and its operating history. The longer dismantlement is deferred, the greater the margin

Table 5: Nuclear Power Reactors Awaiting or Undergoing Decommissioning, 1985

Reactor	Location	Year Plant Entered Service	Number of Years Plant Operated	Capacity (megawatts)	Reactor Type[1]
Shippingport	Pennsylvania	1957	25	72	PWR
G-2, Marcoule	France	1958	22	45	GCR
G-3, Marcoule	France	1959	24	45	GCR
Dresden-1	Illinois	1960	18	210	BWR
Indian Point-1	New York	1962	12	257	PWR
Windscale	United Kingdom	1962	19	33	AGR
Chinon-A1	France	1963	10	70	GCR
Humboldt Bay	California	1963	13	65	BWR
Garigliano	Italy	1964	14	160	BWR
Karlsruhe	West Germany	1965	19	58	PWR
Gundremmingen	West Germany	1966	11	250	BWR
Peach Bottom	Pennsylvania	1967	7	40	HTGR
Douglas Point	Canada	1968	16	206	CANDU
Lingen	West Germany	1968	9	256	BWR
Gentilly-1	Canada	1970	9	250	HWBWR
NPP-A1	Czechoslovakia	1972	7	110	HWGCR
Niederaichbach	West Germany	1972	2	100	HWGCR

[1] Reactor types listed in order they appear in table: Pressurized Water; Gas Cooled; Boiling Water; Advanced Gas; High Temperature Gas Cooled, Graphite Moderated; Heavy Water Moderated PWR (CANDU); Heavy Water Moderated BWR; and Heavy Water Moderated GCR.

Sources: OECD Nuclear Energy Agency, "Compendium on Decommissioning Activities in NEA Member Countries," Paris, January 1985; International Atomic Energy Agency, "The Methodology and Technology of Decommissioning Nuclear Facilities" (draft), Annex 2, Vienna, May 1985; "Decommissioning: Survey of Power Reactor Projects," *Nuclear Engineering International*, August 1985.

of error and the higher the total costs are likely to be. Only seven of the reactors listed in Table 5 are scheduled to be dismantled prior to 1995.[64]

"Although hundreds of nuclear power reactors have been erected around the world, projecting the cost of decommissioning them is still fraught with uncertainties."

André Crégut of the French Atomic Energy Commission asserts that utilities will not proceed with decommissioning until they are more certain of the costs. He thinks present estimates are still so rough that actual costs could easily be at least 40 percent greater than expected.[65]

New regulatory requirements increased reactor construction costs, and it is logical to assume that actual decommissioning costs will also exceed estimates. As experience is gained in decontamination, dismantlement, waste handling, and disposal, inadequacies in existing regulations will emerge. Rules would then become more stringent. The biggest regulatory gaps at present are the lack of criteria for classifying wastes as either radioactive or nonradioactive, the uncertainties regarding the method of transuranic waste disposal, and the absence of "residual radioactivity" standards. Without these guidelines, utilities do not know exactly how much of their wastes will require special disposal and how clean they will have to leave the plant site. If the final rules are stricter than utilities anticipate, cost estimates could rise substantially.[66]

Although hundreds of nuclear power reactors have been erected around the world, projecting the cost of decommissioning them is still fraught with uncertainties. The bill for all the plants now in service could total several tens or several hundreds of billion dollars. No one can now say with confidence which estimate is correct. Only by using state-of-the-art technology to immediately dismantle some of the reactors being taken out of service will the industry be able to ascertain what future decommissioning costs might be.

Saving for the Burial

To ensure that adequate funds will be available, utilities should start setting aside money early in a reactor's life. If money is not collected from ratepayers during the years the plant produces power, the bill will be charged to future customers or taxpayers who did not use the electricity. In the event that regulators forbid the collection of de-

commissioning funds from customers who did not use the nuclear power, the expense might bankrupt utilities or result in de-
34 commissioning shortcuts that could endanger future generations.

A variety of savings mechanisms have been proposed and, like an insurance policy, the plans providing the greatest assurance tend to be the most expensive. One way to guarantee that funds will be available in the future is to deposit all of the needed money in an interest-bearing savings account before the reactor enters service. Interest income will increase the yearly balance of the account and if the initial cost estimate is correct, or if additional deposits are made when estimates are revised, sufficient funds will be available. This strategy is the most expensive and requires utility customers to pay up front for an expense the company will not incur for several decades.[67]

Making periodic deposits into a decommissioning fund is another way to accrue the money. Customers can be charged a fee, based on the amount of electricity they use, that is collected monthly and credited to a decommissioning account. Utilities prefer to place the account on the books but fold the money into the general revenues used to pay all of the company's expenses, including the construction costs of new nuclear plants. This strategy allows the utility to forgo borrowing and keep debt payments low, but the method has been termed "phantom funding" by some observers because the money will be tied up in assets instead of being readily available to the utility when a reactor is retired.[68]

When the time comes to decontaminate and dismantle the plant, a utility with an unsegregated account will probably need to raise cash by selling "decommissioning bonds." Borrowing capital for decommissioning promises to be expensive because investors will require a high return to cover the perceived risks. If large cost overruns are anticipated or if the utility is small with few income-generating assets, investors may shy away from funding plant dismantlement. The market value of the stocks and bonds of several U.S. utilities with heavy nuclear commitments is already less than 50 percent of book value, reflecting lack of investor confidence.[69]

If even high rates of return are not attractive to potential bond purchasers, the federal government or pools of electric utilities ultimately may have to assume the risk. The $2.25-billion bond default by the Washington Public Power Supply System in 1983 has made investors especially wary of publicly owned nuclear projects. Without government commitments to insure the bonds, municipal and cooperative utilities will be particularly vulnerable because they are wholly financed by tax-exempt bonds: There is no equity cushion provided by private shareholders.[70]

If, on the other hand, money is provided by deposits begun when the plant enters service, if the account is managed by professional investors, and if the fund is allowed to grow until it is needed, the utility's financial situation will not be so precarious at plant retirement. Periodic evaluations of reliable decommissioning cost estimates and corresponding adjustments to customer rates will diminish future risks. Swedish utilities revise their decommissioning surcharges annually.[71]

In a study conducted for the NRC, University of Pennsylvania economist J.J. Siegel concluded that if an outside professionally managed fund were established, " . . . it would be virtually impossible for the utility to divert these assets for other uses and funds would be assured no matter what events, legal or financial, occur." He ranked internal funding with no segregated account last in terms of assurance.[72]

Even dedicated decommissioning accounts would be inadequate, however, if a plant closes earlier than expected. If this were to occur, particularly as the result of a costly accident, the utility would find itself with insufficient funds. An insurance policy to protect against premature closure is a frequently proposed remedy, and a sound strategy, if there are companies willing to provide such coverage.

Premature closure policies are not yet available, and insurance companies are unlikely to offer them at affordable rates unless the nuclear industry's operational record improves. Of the reactors that are currently retired and awaiting decommissioning, none operated for a full

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30 years, the lower bound used in utility calculations. Nuclear plants are more complex than other electric-generating technologies, are subject to more design regulations, and have up to ten times as many pipes, valves, and pumps.[73] More parts and a harsher operating environment enhance the potential for breakdowns. Ten of the 17 shutdown reactors listed in Table 5 produced power for less than 15 years.

The least secure funding method postpones collection until decommissioning has begun. Under this strategy, utilities put off until the last possible moment the acquisition of debt that could total billions of dollars. There is no assurance that the money will be available. Such last-ditch efforts are also unfair to utility customers if they are charged for decommissioning a reactor from which they did not receive power.

In countries where the electric-generating system is government-owned, such as France, the "when-needed" principle of funding has frequently been adopted. Utility managers assume that the national or provincial treasury will dole out enough money at the right time to cover the expense of decommissioning. The burden is placed squarely on the shoulders of future taxpayers. The French utility debt is now $30 billion because of the accelerated nuclear construction program, and decommissioning costs may significantly increase already large government budget deficits. Third World governments, many on the edge of insolvency, will be particularly hard-pressed to pay the decommissioning bill for their 23 operating reactors.[74]

Of the four retired commercial reactors in the United States, only one unit had begun to build a decommissioning fund before it shut down. The Pacific Gas and Electric Company, owner of the Humboldt Bay reactor, collected $500,000 during the four years prior to plant shutdown. In 1984, the Critical Mass Energy Project asserted that at least 11 reactors had gone through one third of their operating lives without collecting any funds for decommissioning from ratepayers, and that nationwide only $600 million had been collected. This lack of financial planning prompted nine states to require mandatory periodic deposits into external accounts: California, Colorado, Maine,

"Of the four retired commercial reactors in the United States, only one unit had begun to build a decommissioning fund before it shut down."

Massachusetts, Mississippi, New Hampshire, Pennsylvania, Vermont, and Wisconsin. Only one state, Michigan, does not allow the recovery of decommissioning costs in current rates.[75] 37

Swedish utilities pay an annual decommissioning fee to the federal government. A separate account has been established for each reactor and utilities may borrow from it when their plants are retired. Less formal funding arrangements exist in West Germany and Switzerland.[76]

Decisions about which decommissioning funding strategy to adopt have been postponed for too long. By the end of 1984, the United States had 84 operable power reactors, more than one quarter of the world total. The Soviet Union with 44 was a distant second. (See Table 6.) Yet despite the large number of plants in operation, most utilities are financially unprepared for decommissioning. A 1985 survey of 30 U.S. nuclear utilities revealed that 12 had not conducted site-specific studies of decommissioning costs, 20 were using the funds they had collected for other purposes, and 8 did not expect their current funding method to adequately cover decommissioning expenses.[77]

If instead of the haphazard funding approach now in place, all of a utility's customers made monthly contributions over a 30-year period, decommissioning might be affordable. The average residential electricity consumer in the United States, if served by an all-nuclear electric utility that assumed decommissioning costs of from $200 million to $1 billion for each 1,000-megawatt reactor, would have paid some 5 to 25 percent more for electricity last year. Customers with inefficient electric-heating and air-conditioning systems would have paid more, but those using electricity efficiently would have paid far less. Actual increases would have been considerably lower because no U.S. electric utility relies exclusively on nuclear power.[78]

Commonwealth Edison, an Illinois utility, owns the most nuclear plants in the United States. Its nine operating reactors provide 55 percent of the company's generating capacity, and three more units are under construction. Thus an average residential customer of the

Table 6: Nuclear Power Reactors in Operation, Ten Leading Countries, 1984

Country	Number of Reactors	Total Nuclear Capacity	Share of Total Domestic Capacity	Share of World Nuclear Capacity
		(megawatts)	(percent)	
United States	84	68,536	13	33
Soviet Union[1]	44	22,706	8	11
France	36	28,015	39	14
United Kingdom	32	6,569	10	3
Japan	28	19,025	12	9
West Germany	19	16,127	18	8
Canada	15	8,617	9	4
Sweden	10	7,355	24	4
Spain	7	4,865	12	2
Belgium	6	3,467	28	2
Total	281	185,282		89

[1] Data are for 1983.

Sources: Atomic Industrial Forum (AIF), "International Survey," Bethesda, Md., April 17, 1985; AIF, "Midyear Report," Bethesda, Md., July 10, 1985; Eric Sorenson, International Energy Agency, Paris, private communication, November 8, 1985.

utility would have paid from $20 to $100 in decommissioning charges in 1985. Again, this assumes a decommissioning cost of from $200 million to $1 billion per 1,000-megawatt reactor. This charge, from 3 to 14 percent of the average annual household electric bill, may be acceptable in affluent societies if fee collection is started when the plant enters service and if the reactor operates for a full 30 years. In practice, actual payments will undoubtedly be higher because few plants now in service will have collected money throughout their operating lives.[79]

"Regardless of a nation's future energy plans, existing plants must eventually be scrapped."

Although many nations have not set aside money explicitly for decommissioning, funds for high-level waste disposal are collected in a dozen North American and European countries. In all cases, the money is paid to the government agency responsible for establishing geologic waste repositories. The fee typically ranges from $1 to $6 per 1,000 kilowatt-hours of nuclear electricity produced. The average residential electricity customer in the United States uses some 9,000 kilowatt-hours annually, and only a fraction is produced by nuclear plants.[80]

Setting aside funds for decommissioning is essential in every country that uses nuclear power. Regardless of a nation's future energy plans, existing plants must eventually be scrapped. Decommissioning bills will first fall due in the Soviet Union, the United Kingdom, and the United States—those countries that pioneered the development of nuclear power. Neither nations nor utilities are financially prepared to absorb the projected costs, much less overruns, and their skill at managing the expense will be closely watched. Nations with newer reactors may learn sobering lessons, and countries that have not yet built such plants may have misgivings about doing so when they are better able to assess the true lifetime costs of nuclear energy.

A Long-Term Strategy

Just as today's cities would not be habitable without large fleets of garbage trucks and extensive landfills, the international nuclear industry is not viable without a sound decommissioning strategy. More than 30 years after the first nuclear plant started producing electricity, such a strategy has yet to be formulated. Even if reactor ordering ground to a halt tomorrow, more than 500 reactors, including those currently under construction, will have to be decommissioned. Safely retiring these plants will require new technologies and a plan for disposing of the mountains of radioactive waste that are being created. Aggressive, well-funded research and development programs could pave the way.

Unfortunately, decommissioning planning has lagged far behind re-
actor development. The International Atomic Energy Agency (a
40 United Nations watchdog and research arm) did not hold its first
meeting on decommissioning until 1973, some 19 years after the first
power reactor was built. The initial technical meeting sponsored by
the agency was not convened until two years later. Yet by that time,
hundreds of nuclear power plants were being planned by dozens of
governments and utility companies.

Both national and international atomic energy agencies continue to neglect decommissioning. In the past, research and development money was lavished on fuel reprocessing and breeder reactors. The United States has now abandoned these projects and is redirecting the funds to military and space applications. Since 1978, more nuclear reactors have been cancelled worldwide than have been ordered. Industry emphasis is on creating new business, not demolishing old reactors. Research and development for decommissioning is not even included as a category in detailed DOE and NRC budgets.[81]

The Nuclear Energy Agency, a body of the OECD, encourages the exchange of information, materials, and personnel among member countries, but offers no financial assistance. And the much touted decommissioning research program of the European Communities is authorized to spend only $11 million during the five-year period that began in January 1984. In constant dollars, the total five-year budget is less than it cost to build one small demonstration reactor 20 years ago.[82]

The biggest stumbling block for all nations with nuclear plants is the lack of permanent disposal facilities for radioactive wastes. Although many reactor operators agree that plants should be dismantled as quickly as possible after shutdown, that option has been foreclosed until at least the turn of the century. In countries like Japan, where land for any type of power plant is scarce, unproductive use of real estate is expensive.

No country currently has the capability to permanently dispose of the high-level wastes now stored at a single reactor. And the already daunting task of managing low-level operating wastes is only the tip of the iceberg. As reporters Donald Barlett and James Steele have observed, "If the politicians and scientists in charge of nuclear waste had been running the space program, John Glenn [the first U.S. astronaut] would still be orbiting the earth today." And, if nuclear plant construction estimates made in the seventies had come to pass, lack of adequate waste sites might have crippled the industry. In 1970, the OECD projected that its member nations in Western Europe, North America, and Japan would have 563,000 megawatts of nuclear capacity by 1985, more than double the amount now in operation.[83] Slower-than-anticipated ordering and rapidly increasing construction and operating costs thwarted many nations' nuclear programs even before the complicated issues of decommissioning and waste disposal came to the fore.

But in some areas, including France, Japan, and northeastern North America, the use of nuclear power may have already expanded too rapidly. Each area has a relatively dense concentration of nuclear plants, but no detailed plan to decommission them. Given the limitations of current knowledge, those nations still committed to building more reactors—namely France, Japan, and the Soviet Union—might be wise to reconsider their construction programs. The full economic and social costs of using nuclear power will not be known until the many uncertainties associated with decommissioning are eliminated. Multibillion-dollar construction decisions made today will be based on incomplete information.

Without detailed regulations and technical guidelines, and the availability of disposal sites, utilities cannot plan intelligently for the future. Some utilities started reactor construction with designs only 20 percent complete and discovered that because of regulatory changes they were not even that far along. The consequences of inadequate planning for decommissioning would be not only costly but dangerous. If rules defining which wastes require special treatment or what constitutes a clean site are not issued until decommissioning is under way, utilities may find themselves short of funds. Financially troubled utilities might even declare bankruptcy and abandon the plant.

Many orphaned hazardous waste sites were previously owned by now defunct companies. 42

Early knowledge of decommissioning requirements would also allow engineers to incorporate design changes that would facilitate later decontamination and dismantlement efforts. A simple concept that was not considered by the manufacturers of the first nuclear plants was the value of putting a protective coating on all surfaces that would be exposed to radiation. Even a thick layer of removable paint reduces the surface contamination of structural components and thus the volume of low-level wastes. Limited experience with neutron-activated wastes indicates that their quantities can also be diminished by regulating the amount of neutron-absorbing impurities used in reactor steel and concrete. Several countries now require utilities to submit decommissioning proposals at the design stage. But hindsight will only benefit the trickle of reactor orders yet to come, not the hundreds of units in operation.[84]

A look at the decommissioning funding mechanisms in place in various countries indicates that we expect our children to pay our electricity bills. Without savings programs that equitably share decommissioning costs and assure that funds will be available when needed, today's electricity customers are getting a free ride. The longer funds collection is deferred, the greater annual payments will have to be in order to accumulate enough money. Only by periodically updating site-specific cost estimates, instead of relying on generic studies for hypothetical power plants, can utilities hope to build sufficient savings. Waiving tax liabilities on the money deposited in trust funds and the interest earned on that money could also hasten the growth of decommissioning accounts.[85]

Because many plants operated for years without collecting money for decommissioning, electricity customers and taxpayers will suffer the "aftershock" of paying for retired reactors. The less money set aside while the plant produces power, and the more actual decommissioning costs diverge from estimates, the greater the aftershock will be.

> **"Because many plants operated for years without collecting money for decommissioning, electricity customers and taxpayers will suffer the 'aftershock' of paying for retired reactors."**

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During the next three decades, more than 350 power reactors will be taken out of service. Immediately dismantling some of the largest or most problematic reactors as part of an international test case would yield valuable lessons for future decommissioning projects. Firsthand experience would shed light on the reasonableness of the theories and assumptions now used for planning purposes. The plant owners could cover half the costs with governments and research institutes from around the world contributing the rest. Logical coordinating bodies would be the International Atomic Energy Agency in Geneva or the Nuclear Energy Agency in Paris. A similar, ad hoc arrangement is in effect at the damaged Three Mile Island unit, with U.S. utilities, the U.S. Department of Energy, and various international participants contributing money in order to learn firsthand about the most advanced decontamination and dismantlement techniques.

Taking full advantage of the learning experience offered by the reactors now coming out of service is sometimes viewed as a needless expense. But saving millions of dollars today could result in spending billions of extra dollars tomorrow.

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Mr. **Volkmer**. Thank you very much, Ms. Pollock.

The gentleman from California.

Mr. **Packard**. Thank you, Mr. Chairman.

Ms. Pollock, what do you consider the most difficult part of decommissioning?

Ms. **Pollock**. The physical decommissioning?

Mr. **Packard**. Yes.

Ms. **Pollock**. The radiation levels encountered, and the dismantlement of the pressure vessel.

Mr. **Packard**. Do you believe that the current regulations address those concerns adequately, the current rules?

Ms. **Pollock**. The rules don't really address the development of technologies or the procedures that will be required to dismantle the plants; it is more on the disposal and financing arena. I don't think there are any major gaps in that, no.

Mr. **Packard**. So, would you agree then with AIF that the rules are adequate that we now have in place?

Ms. **Pollock**. No, I would not agree that those rules are adequate, and I mention some of those problems being the amount of money that is recommended to be set aside, the funding mechanisms, and the strategies available for decommissioning; which now include entombment, which, I think, is inappropriate.

Mr. **Packard**. In your written testimony, you state that regulatory requirements increased reactor construction costs, and it is logical to assume that it would also increase decommissioning costs. On what basis do you make that assumption?

Normally, the tearing down is an entirely different process than building, especially something that is as complicated as a nuclear reactor.

Ms. **Pollock**. That is correct; it is a different procedure. However, it is one with which we have very little experience to date, and because of that lack of experience, we are not necessarily aware of all the problems that would be encountered in the future.

In the area of low-level waste disposal, for example, several of the earlier sites have been closed down because they weren't deemed to be safe. The future sites will be much more stringent in their regulations and packaging, et cetera, required. Other aspects such as that, I anticipate, will be discovered in the future.

Mr. **Packard**. By the time the bulk of our plants will require decommissioning, do you expect new technology will assist us in filling in those voids and gaps?

Ms. **Pollock**. If there is adequate funding and research to develop those technologies, yes.

Mr. **Packard**. If decommissioning technology such as robotics is being developed overseas, do you feel that it is necessary that the U.S. fund the same research?

Ms. **Pollock**. No, if there is adequate technology transfer; if the product is developed elsewhere, we can certainly use the same one.

Mr. **Packard**. Are you as concerned about the decommissioning and the controls with decommissioning—let me restate. Are you as concerned—or were you as concerned about the construction and the rules and regulations in terms of construction, as you are the decommissioning?

Is your concern—I have to assume that you have had great concern in the past, as many of us had, in terms of the construction and the building of nuclear plants. Do you have the same concerns in terms of decommissioning?

Ms. POLLOCK. Yes, I do. And as regards decommissioning specifically, I think there could have been some aspects considered much earlier on that would have helped us with what we are going to encounter. For example, sealing the concrete surfaces would have diminished the amount of contaminated concrete that we will encounter in the future of the amount that needs to be disposed of.[71]

In addition, there are no strict regulations as to the composition of materials used in construction. Surveys in the United States have shown that cobalt and niobium concentrations in stainless steel vary more than tenfold at different reactors. Those variations in concentration will result in different levels of radiation as well.

Mr. PACKARD. The decommissioning process is really not going to get seriously get underway for another decade at least.

Ms. POLLOCK. Well, there are four retired plants, but there is no place to which they can send the spent fuel, so they are strapped at this point. Storage is the only option available to them.

Mr. PACKARD. You mention also that you do not agree with the process of entombing—that it ought not to be an option available. Explain why you feel that way.

Ms. POLLOCK. Because I think that any protective structure used to entomb the reactor would decay long before the radioactivity within. I think there have been a number of industry studies which document the long life of many of the radionuclides involved and that they will continue highly radioactive long after a protective structure.[72]

Mr. PACKARD. But in the entombing option, they are not looking beyond 100 years, and they would not be operating plants, so they would not be creating new radioactivity. In fact, on the other option, which is to delay for 40 or 50 years, the purpose of that option is to allow time for the radioactivity to, by nature, decrease and not to be quite as much of a problem as if we decommissioned immediately. It would appear to me that the longer that it rests in an entombed condition that the radioactivity would become less and less by nature's own processes?

Ms. POLLOCK. That is certainly correct.

Mr. PACKARD. For that reason I am wondering if entombing would have the concerns that you have expressed?

Ms. POLLOCK. I think in the past entombment has traditionally been considered to be a permanent solution, that the reactor would be entombed and it would sit there forever. The NRC in the proposed regulations talks about entombment for a period of 100 years.

I don't think there would be an incentive for utilities to entomb a plant for that period of time. I would think they would be much more likely to put it in storage for several decades, probably not more than about 50 years, and then dismantle the plant.

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[71] Ms. Pollock changed the sentence to read, "For example, sealing the concrete surfaces would have diminished the amount of contaminated concrete that we will encounter in the future and thus the amount that will require disposal."

[72] Ms. Pollock changed this phrase to read, ". . . they will continue to be highly radioactive long after a protective structure would give way."

After 100 years, they are probably still going to have to go back in and take it apart, because the—as the NRC regulations say, it would have to meet clean-site conditions after 100 years. It wouldn't do that.[73]

In addition, you asked about the decay of the radionuclides; there are a number of both short-lived and long-lived radionuclides that would be encountered. Elements such as cobalt, that have a half-life of 5 years, would certainly be almost gone after[74] time, if you are talking about 100 years. There are elements, though, that have half-lives of hundreds, or thousands, or tens of thousands of years; those would not have decayed substantially after a 100-year waiting period.

Mr. PACKARD. Thank you.

Mr. VOLKMER. Do you believe that the new Atomic Industrial Forum guidelines for estimating decommissioning costs provide accurate measures of the cost for these activities? Have you reviewed those guidelines?

Ms. POLLOCK. I have reviewed them. I think they are certainly a step in the right direction in that they will standardize the cost estimates that utilities use.

At this point there are a number of different variables included by different companies and it is very difficult to make comparisons of those cost estimates. So I think that they will be a real help.

As to the dollar figures used for cutting a foot of pipe, for example, I haven't examined them in enough detail to know that I agree with that. I think that those costs will evolve over the years, up or down, depending on how our knowledge base increases.

I think disposal costs will certainly continue to rise. I think that if we encounter surprises because plants have sat too long and don't have the option of being able to get advice from people familiar with them, that may also increase costs.

Mr. VOLKMER. There appears from reading your paper and listening to your testimony, that I think some of the largest obstacles that you see, will not be just costs, and recovering the costs early, so they are ready when it is decommissioned, but the question of disposal. I think you seem to emphasize that may be one of the things that is going to be a serious problem, either not having the facilities, or the cost of the facilities, utilization of those facilities, those commercial sites; is that correct?

Ms. POLLOCK. That is correct.

Mr. VOLKMER. I think there is probably some basis for that. We saw what happened when we passed the law in 1980, and we had to repass one in 1985 because it didn't get done.

Ms. POLLOCK. That is correct. Now, with the high-level waste repositories, with the DOE's decision not to develop a repository in the East that has caused a backlash by western Senators who don't want to be the only dumping ground, so the future of that act is in more question than would have been the case a couple of years ago.

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[73] Ms. Pollock added the words "without dismantlement".

[74] Ms. Pollock inserted the words "that amount of" here.

Mr. **Volkmer**. The old thing of "any place else, but not my back yard."

Ms. **Pollock**. Exactly.

Mr. **Volkmer**. Is there any movement—perhaps, I should ask Mr. Levy this question, but since you have studied maybe you can tell me the problems with it, even if it is just an idea that I had. If you can't, then we will see if, maybe, we can get Mr. Levy back before we go to the final panel.

And that is the question of the industry itself developing low-level waste sites.

Ms. **Pollock**. That has traditionally been a responsibility of the States and not the utilities. States are now responsible for the waste generators in their border.[75]

It has been very difficult because the largest contributor is the nuclear industry and they have not, perhaps, had as much input in the development of these regulations.[76] But, to date, disposal is not their responsibility.

Mr. **Volkmer**. So you don't really see that as a possible solution to having waste sites, low level?

Ms. **Pollock**. Certainly something to be looked at, I suppose.

Mr. **Volkmer**. I was just thinking about it out here as—for sure they are the ones—they are not the only ones, we have a lot of low-level waste generators, not just the nuclear industry—but they are going to come somewhere in the late 1990's, and through the years 2030, at least, they are going to be needing quite a bit of it.

Ms. **Pollock**. But they are already the majority contributors. And as we start facing the dismantlement of reactors they will produce several times as much as other sources.

Mr. **Volkmer**. Do you also see the fact that we may not have the high-level waste repositories ready as being an impairment of being able to decommission these plants; correct?

Ms. **Pollock**. I do; because the only option available to utilities, if there are no repositories available, is to put them in storage until they are available. So, if immediate dismantlement is the preferred option, and several surveys have indicated that utilities would prefer to do that, they are not able to. It is not an option available to them presently.

Mr. **Volkmer**. Your report describes gaps in regulatory standards for waste classification, disposal methods, and residual radioactivity standards; do you know if work is underway to address these deficiencies?

Ms. **Pollock**. There is work underway; EPA is supposed to issue the residual radioactivity standards. They have been charged with that responsibility for several years and not very much has been forthcoming. As to when they will issue final regulations, that is unclear.

I believe they would also have the responsibility of deciding what type of waste requires special disposal.

As far as transuranics go, as we have heard today, that is the responsibility of DOE. But transuranics don't qualify as low-level wastes, nor have they been classified as high level, so it unclear how they will be disposed of.

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[75] Ms. Pollock changed this sentence to "States are now responsible for the wastes generated within their borders."

[76] Ms. Pollock inserted the words ". . . as they should have."

Mr. **Volkmer**. But they will be the responsibility of DOE to dispose of them, as I understand the present law?

Ms. **Pollock**. Right.

Mr. **Volkmer**. I have no further questions.

Do you have any?

Mr. **Packard**. I have none, Mr. Chairman.

Mr. **Volkmer**. I want to thank you for being here, Ms. Pollock. I appreciate your testimony.

You have been very helpful. Like I said, your paper was very good for background material for me; it raised quite a few questions.

With that, now we have got a vote on. We will go vote, and then come back. We will finish up with our final panel at that time.

[Recess.]

Mr. **Volkmer**. The subcommittees will continue hearings.

Our final panel will provide us with opinions and information from utilities operating nuclear reactors.

Dr. Larry Papay, the senior vice president for the Southern California Edison Co., will discuss their San Onofre and Palo Verde powerplants.

From the Pacific Gas & Electric Co., we welcome Mr. Terry Nelson, decommissioning project manager for the utility's Humboldt Bay Plant 3; and he is accompanied by Mr. Louis Vincent, an attorney who argued the company's position on decommissioning filings before the California Public Utilities Commission.

Gentlemen, your statements will be placed in the record, at this point in the record. You may either summarize that statement or you may review it in full, however you so desire.

Dr. Papay, you may begin.

STATEMENTS OF LARRY PAPAY, SENIOR VICE PRESIDENT, SOUTHERN CALIFORNIA EDISON CO., ROSEMEAD, CA; TERRY NELSON, DECOMMISSIONING PROJECT MANAGER, HUMBOLDT BAY REACTOR, PACIFIC GAS & ELECTRIC CO., EUREKA, CA, ACCOMPANIED BY LOUIS VINCENT, ATTORNEY, PACIFIC GAS & ELECTRIC CO.

Dr. **Papay**. Thank you, Mr. Chairman. I appreciate this opportunity to present the views of Southern California Edison on this important subject.

Southern California Edison is committed to the development and implementation of plans necessary to ensure that the retirement of our nuclear units is carried out safely and economically. Toward that end, we have developed retirement cost estimates, and implemented the necessary financial mechanism, to accomplish the retirement of our nuclear units at the end of their useful lives.

We are encouraged by the increasing interest in nuclear powerplant retirement, and believe that industry involvement in the development of technical and financial decommissioning criteria is vital.

We have been involved with both San Onofre and the Palo Verde nuclear sites, as you mentioned. Our first facility, San Onofre unit

1, is a 436 megawatt plant which went into commercial operation on January 1, 1968. San Onofre units 2 and 3 are each capable of producing 1,100 megawatts, and went into operation in 1983 and 1984, respectively.

We also maintain a 16-percent interest in the Palo Verde nuclear generating station in Arizona, which ultimately will consist of three identical 1,270 megawatt units operated by the Arizona Public Service Co.

In February 1985, the Nuclear Regulatory Commission published a proposed rule which defines decommissioning as: "To remove nuclear facilities safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of license."

Therefore, retirement consists of decommissioning a nuclear unit, followed by the demolition and disposal of all noncontaminated structures and equipment, and restoration of the site.

Our position is that the cost of the eventual retirement of the San Onofre units, for example, should be borne by those who receive the benefits of the facilities throughout the operating life of the units.

In the case of San Onofre unit 1, an initial cost estimate for decommissioning was prepared in 1976, and for units 2 and 3, the initial cost estimate was prepared in 1979. Since that point in time, we have updated these costs every 2 years.

These cost estimates address the planning and procedures necessary to carry out the retirement of the facility, including: The steps required to obtain what is called a "possession-only" license; the decontamination of structures and systems; fuel shipment; and removal, transportation and disposal of all radioactive material. In addition to these decommissioning activities, the utility's retirement cost estimate also addresses the demolition and disposal of the remaining noncontaminated structures and equipment, and the restoration of the site to essentially its preconstruction condition.

We have actively participated in industry groups and committees, such as the AIF, EEI, and the EPRI, or Electric Power Research Institute, External Fuel Subcommittee, in order to keep abreast of the changes in the regulations and technology in the areas relative to decommissioning and retirement.

The retirement of the Shippingport Nuclear Plant in Pennsylvania will provide the industry with valuable experience relating to decommissioning procedures, occupational exposure data, and personnel requirements.

In order to assist utilities in their nuclear powerplant retirement planning and cost estimating, it is essential that the technical, financial and administrative aspects of the Shippingport experience be identified, assessed, and made available to the industry. Southern California Edison believes that this transfer of information to utilities can be performed most effectively through the participation of industry organizations.

Our comments on the proposed rule have emphasized the importance of performing a site-specific retirement cost estimate, particularly at plants such as San Onofre where the unique characteristics of its high seismic design can impact retirement costs significantly.

I might add, parenthetically, to correct an impression that may have been left by an earlier panel member, we are not located on a fault. We spent a great deal of money to understand what the geology was, both onshore and offshore. But it is, in fact, true that we are in a seismic zone 3, and therefore the seismic design at San Onofre, as well as other plants located in California, is to a very high standard.

In the last 20 years, industry and public agencies have published numerous reports containing generic information applicable to the development of cost estimates. However, generic studies that correlate the power rating of a nuclear unit to its retirement costs fail to consider the unique unit and site-specific characteristics of the nuclear power station. In certain instances this generic approach has been inappropriately applied to derive cost estimates which are not representative of the actual cost of retirement.

And I might supplement my statement at this point, based upon some comments that were made earlier, with the experience we have had at San Onofre. The retirement costs at San Onofre are currently being collected through depreciation, in what is called negative-net-salvage, which is gross salvage minus the cost of retirement.

The funds collected are retained internally and are used at the company's discretion. This procedure is beneficial to ratepayers since it helps to reduce the company's cost of capital.

In California they have passed a law dealing with an external fund, and my neighbors to the north will talk a little bit about that.

The annual ratepayer contributions for San Onofre retirement costs are calculated using a straight line, remaining life methodology. And these are updated, based upon our updated cost estimates, when we go in for general rate cases.

Now, in contrast to that, about 93 percent of our total revenues come from State public utility commission jurisdiction; 7 percent comes from wholesale customers through FERC.

In 1982, in a FERC proceeding, the FERC staff and several of our wholesale customers contested the cost estimates prepared by our independent consultant. And the retirement cost estimate of the FERC staff and these wholesale customers were based on a generic cost estimate methodology, resulting in cost estimates that were less than 40 percent of the estimates being proposed by us and being part of the California jurisdiction.

So, 93 percent of the customers are paying a proportionate share of retirement costs, based upon our estimate; 7 percent of our customer base, so to speak, is paying a disproportionately low share. Obviously, we are appealing the decision, the administrative law judge's recommendation, in this particular case.

Accordingly, in order to develop an accurate estimate of the ultimate cost of retiring these units it is important to recognize the unique feature of each unit and account for it in developing a site-specific retirement cost estimate.

Thank you for this opportunity to present our views to the subcommittee. I would be happy to answer questions.

[The prepared statement of Dr. Papay follows:]

Prepared Testimony

of

DR. LAWRENCE T. PAPAY
Senior Vice President
Southern California Edison Company

CONCERNING THE ACTIVITIES AND EXPERIENCE OF THE SOUTHERN CALIFORNIA EDISON COMPANY IN THE AREA OF NUCLEAR POWER PLANT RETIREMENT

Before the
Subcommittee on Energy Research and Production

and the

Subcommittee on Investigations and Oversight

of the

United States House of Representatives Committee
on Science and Technology

July 30, 1986

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I. Introduction

Mr. Chairman, Madame Chairman, members of the Subcommittees, I appreciate this opportunity to present the views of the Southern California Edison Company (SCE) on the important subject of nuclear power plant decommissioning.

My name is Lawrence T. Papay, Senior Vice President of the Southern California Edison Company. One of my corporate responsibilities is oversight of the preparation of cost estimates and the development of plans and schedules necessary to undertake the eventual retirement of the Company's nuclear power plants.

Southern California Edison Company is committed to the development and implementation of plans necessary to ensure that the retirement of our nuclear units is carried out safely and economically. Toward that end, Southern California Edison has developed retirement cost estimates and implemented the necessary financial mechanism to accomplish the retirement of our nuclear units at the end of their useful lives.

As the focus of nuclear power has shifted from the construction of new facilities to the operation and maintenance of existing plants, increasing attention is now being paid to both the technological and financial aspects of nuclear power plant retirement. We are encouraged by this increasing interest and believe that industry involvement in the development of technical and financial decommissioning criteria is vital.

II. Southern California Edison's Involvement in Nuclear Power Generation

The Southern California Edison Company has been a pioneer in the field of nuclear power. In the early 1960's the Company was faced with the twin challenges of meeting the ever increasing energy demand in the rapidly growing Southern California area while at the same time remaining sensitive to environmental demands. To meet these challenges, the Company determined that its approach to additional electrical power generation would be guided by two principles:

(1) diversification of our generation resources, and

(2) application of emerging, cost-effective technologies.

With these criteria in mind, the Company decided to add nuclear power to its mixture of generation resources.

Since that decision, Southern California Edison has been involved with both the San Onofre and Palo Verde nuclear sites.

Our San Onofre site is located on the Pacific coastline approximately midway between the Los Angeles and San Diego metropolitan areas. Southern California Edison has an 80% interest in the San Onofre Unit 1 plant, a 436 megawatt facility which went into commercial operation January 1, 1968. We have a 75% interest in the other two plants on the site, San Onofre Units 2 and 3. These latter units are of an identical, mirror image design, each capable of producing 1100 megawatts. San Onofre Unit 2 commenced commercial operation on August 18, 1983, with San Onofre Unit 3 going commercial less than nine months later on April 1, 1984.

In addition to being the principal owner and operator of the three San Onofre units, Southern California Edison also maintains a 16% interest in the Palo Verde Nuclear Generating Station. This complex, located about 55 miles west of the Phoenix, Arizona metropolitan area, consists of three identical 1270 megawatt units which are operated by the Arizona Public Service Company. Palo Verde Unit 1 went into commercial operation on February 13, 1986. Palo Verde Units 2 and 3 are in their startup phase, with

Unit 2 expected to go commercial late this year, followed by Unit 3 in early 1988.

Our San Onofre Unit 1 facility was one of the original plants used to not only demonstrate the viability of nuclear power, but also to promote utility interest in this new form of power generation. It is now the fourth oldest commercial nuclear power plant in this country which is still in operation. With such an early involvement in nuclear power production, Southern California Edison has accrued an unprecedented level of experience in plant safety, regulatory compliance and operational excellence. These are the three aspects which have been, and will continue to be, the cornerstone of our nuclear philosophy. We consider our responsibility to both our shareholders and the general public welfare that, having played a significant developmental role in the birth of the nuclear power industry, we also apply our accumulated expertise to ensure these facilities are retired in a safe, cost-effective, prudent manner.

III. Southern California Edison's Involvement in Retirement Activities

In February 1985, the Nuclear Regulatory Commission published a proposed rule which defines decommissioning as:

> "To remove nuclear facilities safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of license."

Therefore, retirement consists of decommissioning a nuclear unit, followed by the demolition and disposal of all noncontaminated structures and equipment, and restoration of the site.

Southern California Edison's position is that the cost of eventual retirement of the San Onofre units should be borne by those who receive the benefits of the facility. To ensure that funds are available for retiring the units at the end of their useful lives, the retirement costs must be accumulated over the operating life of the units. As a basis for establishing adequate annual accrual levels, Southern California Edison has prepared and updated retirement cost estimates for each of the San Onofre units.

In late 1976, an independent consultant was hired by Southern California Edison to prepare a cost estimate for the retirement of San Onofre Unit 1. The estimate was developed taking special consideration of the unique plant design and site characteristics of Unit 1. For that purpose, the contractor worked at the site for an extended period of time in order to become intimately familiar with the unique characteristics of the various plant structures and equipment.

In 1979, Southern California Edison directed our consultants to prepare a retirement study for Units 2 and 3. These units are different in design and layout than Unit 1 and the consultants once again reviewed the drawings, cost data and site facilities to ensure that the cost estimate took into account the unique design characteristics of these units.

The retirement cost estimate of each unit addresses the planning and procedures necessary to carry out the retirement of the facility, including: the steps required to obtain a "possession only" license; the decontamination of various structures and systems; fuel shipment; and, removal, transportation and disposal of all radioactive material. In addition to these decommissioning activities, the retirement cost estimate also addresses the demolition and disposal of remaining noncontaminated structures and facilities, and restoration of the site to essentially its pre-construction condition.

The key features of each of the retirement estimates include the project schedule for each major activity, and the yearly cost of the retirement work. The estimates also include the costs of insurance, security, transportation and disposal of low level waste at available repositories, and the transportation and disposal of all noncontaminated material.

These retirement cost estimates are updated biennially to account for regulatory changes, as well as changes in decommissioning technology and demolition methods. The current retirement cost estimates for dismantlement of each of the San Onofre units are: $137 million for Unit 1; $149 million for Unit 2; and $169 million for Unit 3. Of the three (3) decommissioning alternatives, the dismantlement of the units following shutdown was the most cost effective alternative. Since these estimates include all retirement costs, they are consistent with estimates identified by the Department of Energy for decommissioning the Shippingport facility.

Southern California Edison has actively participated in industry groups and committees in order to keep abreast of the changes in regulations and technology in the areas of decontamination, transportation and disposal of radioactive wastes. Southern California Edison is a member of the Utility Decommissioning Group of the Atomic Industrial Forum, the External Fuel Subcommittee of the Electric Power Research Institute and has been a member of the Atomic Industrial Forum task force that was responsible for the development of the study entitled, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates."

Finally, Southern California Edison has an interest in the activities that will ultimately lead to the retirement of the Shippingport and Humboldt Bay nuclear units. The experience gained from these retirement projects will be most valuable to our future retirement planning.

IV. Decommissioning Technology and Experience

The retirement of the Shippingport Nuclear Plant in Pennsylvania will provide the nuclear industry with valuable experience relating to decommissioning procedures, occupational exposure data and personnel requirements. In addition, actual costs incurred in the packaging, shipping and burial of Shippingport's radioactive waste will be useful in evaluating our existing cost estimates.

In order to assist utilities in their nuclear power plant retirement planning and cost estimating, it is essential that the technical, financial and administrative aspects of the Shippingport experience be identified, assessed and made available to the nuclear industry. Southern California Edison believes this transfer of information to utilities can be performed most effectively through participation in industry organizations such as the Electric Power Research Institute and the Atomic Industrial Forum. Southern California Edison commends the Department of Energy's efforts in this regard.

Additionally, Southern California Edison concurs with the decision of the Department of Energy to engage numerous subcontractors in the Shippingport decommissioning project. This decision will serve the objective of distributing the experience gained from the project throughout industry.

V. NRC Proposed Rule on Decommissioning

As I previously mentioned, the Nuclear Regulatory Commission in February 1985 published in the Federal Register a proposed rule on Decommissioning Criteria for Nuclear Facilities. The proposed rule represents the results of a reevaluation of the Commission's decommissioning policy and addresses issues relating to decommissioning alternatives, timing, planning and financial assurance. The proposed rule considers only the technical and financial aspects of decommissioning nuclear facilities, and does not address the demolition of nonradioactive structures or restoration of the power plant site, neither of which are required for NRC license termination.

Southern California Edison has actively participated in the preparation of comments on the proposed rule through both our nuclear engineering organization, and through our participation in the Utility Decommissioning Group of the Atomic Industrial Forum.

Southern California Edison's comments on the proposed rule have emphasized the importance of performing a site specific retirement cost estimate, particularly at plants such as San Onofre where the unique characteristic of its high seismic design can impact retirement costs significantly. In order to provide assurance that funds will be available at the time of decommissioning, funding levels must be based on estimates of the expected cost of retirement. As I previously discussed, Southern California Edison establishes its funding levels based on cost estimates performed by an independent consultant.

The proposed rule considers that "[f]or electric utility applicants and licensees, the amount of funds assured can be based either on an amount prescribed in the regulations or on a facility-specific cost estimate..." (50 FR 5602). The amount prescribed in the proposed rule is $100 million (1984 dollars). This amount includes only the cost of decommissioning and does not account for costs associated with demolition of noncontaminated structures or restoration of the site.

Southern California Edison endorses the position of the Atomic Industrial Forum that funding levels should be based on site specific cost estimates and not on a "prescribed" amount based on a generic study. Moreover, the fact that the $100 million accounts only for the decommissioning portion of the total retirement cost, may lead to an unintentional or inappropriate use of the amount in a ratemaking proceeding.

VI. Retirement Cost Estimates

In the last 20 years, industry and public agencies have published numerous reports containing generic information applicable to the development of cost estimates. However, generic studies[1/] that correlate the power rating of a nuclear unit to its retirement cost, fail to consider the unique unit and site specific characteristics of the nuclear power station. In certain instances this generic approach has been inappropriately applied to derive cost estimates which are not representative of the actual cost of retirement.

For example, our San Onofre units are unique in their high seismic design, and, consequently, the structures contain more concrete and are more heavily reinforced than similar structures in lower seismic areas. Accordingly, in order to develop an accurate estimate of the ultimate cost of retiring these units, it is important to recognize this unique feature of each unit and account for it in developing a site specific retirement cost estimate.

VII. Conclusion

Southern California Edison Company appreciates this opportunity to present its view on the important subject

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[1/]
1. USNRC, Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station. NUREG/CR-0130, June 1978
2. USNRC, Technology, Safety and Costs of Decommissioning a Reference Backing Water Reactor Power Station. NUREG/CR-0672, June 1980

of nuclear power plant retirement. As a leader in the nuclear industry, Southern California Edison recognizes the importance of prudent financial and technological planning for nuclear power plant retirement. Our views are based on our background and experience in the nuclear power industry, as well as our continued interaction with industry committees, regulatory bodies and other utilities. We believe the experience gained at Shippingport will be useful in planning for future nuclear power plant retirements. We wish to reiterate that regulatory restraint and technological flexibility are essential features which must be maintained.

Again, thank you for the opportunity to present our views to the Subcommittee. I would be happy to answer any questions you may have regarding my testimony or other matters involving our Company's retirement activities of our nuclear power plants.

Thank you.

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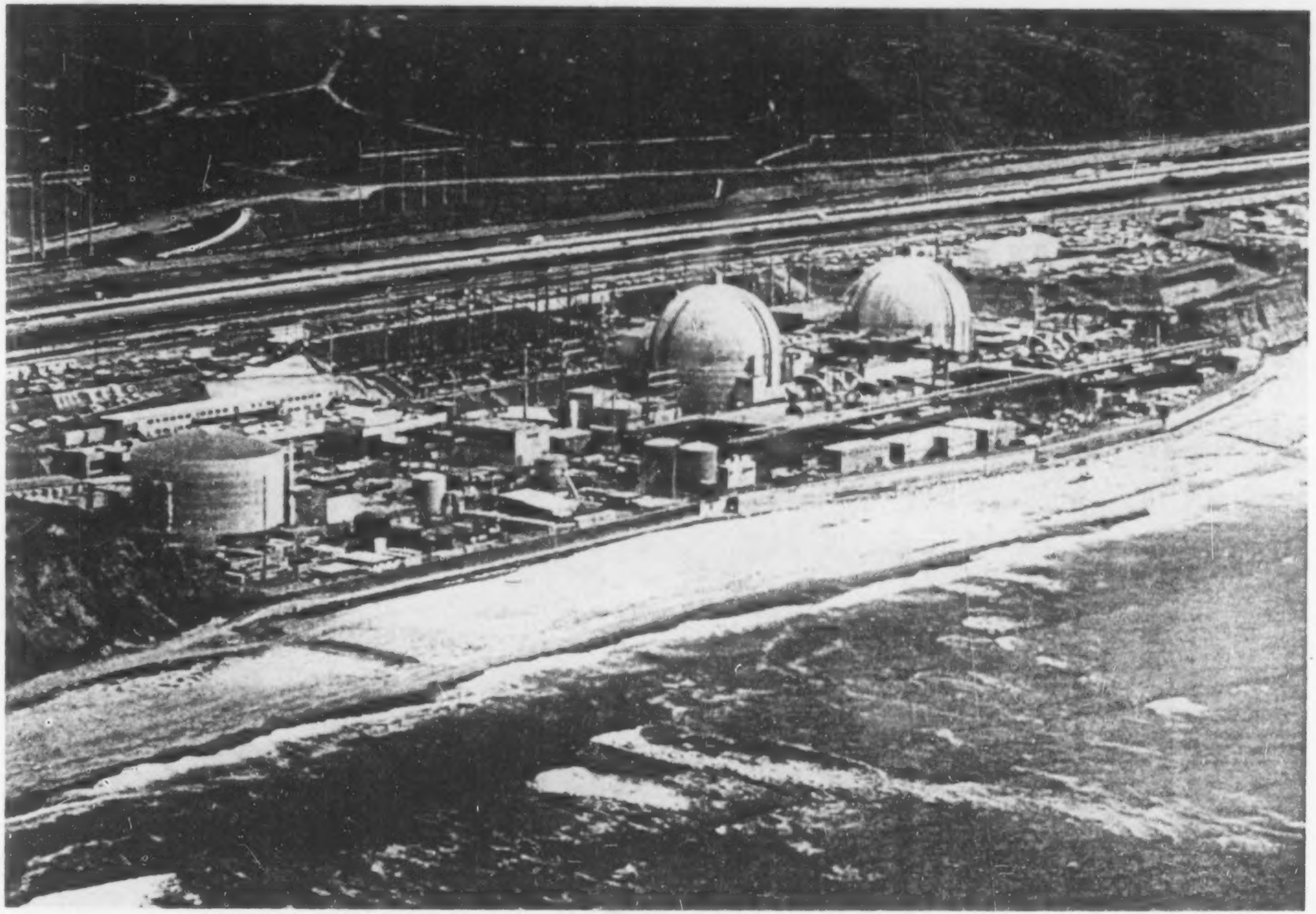
7/28/86



BIOGRAPHICAL SKETCH
LAWRENCE T. PAPAY

Dr. Lawrence (Larry) T. Papay, born in New Jersey, earned a Bachelor's Degree in Physics from Fordham University and a Master's and Doctorate in Nuclear Engineering from the Massachusetts Institute of Technology. He is a Registered Professional Nuclear Engineer in California.

Dr. Papay began his career with the Southern California Edison Company in 1970 as Director of Research and Development. In 1978, he was assigned to the position of General Superintendent to manage utility bulk power operations. He was elected Vice President in January, 1980, at which time he assumed management of the utility's research and development, and quality assurance organizations, and was elected Senior Vice President on May 19, 1983. At present, the Nuclear Generation Site; Nuclear Engineering, Safety & Licensing; and Power Supply Departments report to him.

In the past, Dr. Papay has served with the Federal Office of Technology Assessment, Solar Advisory Panel; Federal Power Commission's Technical Advisory Committee on Research and Development; U. S. Department of Energy Solar Research and Development Panel of Energy Research Advisory Board; National Science Foundation Solar Energy Panel; Electric Power Research Institute (EPRI) Advanced Power Systems Divisional Committee; EPRI Energy Analysis and Environment Divisional Committee; EPRI Steam Generators Owners Group; EPRI Fuel Cell Users Group Management Committee; Edison Electric Institute Research Management Subject Area Committee; Editorial Advisory Boards for the Solar Law Reporter and Energy Resources; Massachusetts Institute of Technology Corporation Visiting Committee for the Department of Nuclear Engineering; California State Polytechnic University, Pomona, School of Science Advisory Council; California State University, Fullerton, School of Math, Science and Engineering Advisory Board; National Research Council, Committee on Electricity in Economic Growth; chairman of EPRI Research Advisory Committee; and Utility Coal Gasification Associates Board.

Dr. Papay is presently a member of the American Nuclear Society and its Special Committee on Public Education; Pacific Coast Electrical Association; National Science Foundation Industrial Panel on Science and Technology; Renewable Energy Institute Board of Directors; Department of Energy, Energy Research Advisory Board; Atomic Industrial Forum Board of Directors; and California State University, Los Angeles, Industry Advisory Committee.

In addition, Dr. Papay is on the Board of the San Gabriel Valley Council Boy Scouts of America; United Way Region II Board; Arcadia Planning Commission; a former member of the Arcadia Olympics Commission; past president of the Arcadia Booster Club; and past president of the Santa Anita Oaks Homeowners' Association.

Dr. Papay resides with his family in Arcadia, California.

7/18/86

Mr. VOLKMER. Thank you very much.

Mr. Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

My name is Robert T. Nelson. I am the project manager for the decommissioning of the Pacific Gas & Electric Co.'s Humboldt Bay Powerplant Unit No. 3. With me today is Mr. Louis Vincent, who will be available to answer any questions you may have regarding the regulatory recovery of decommissioning costs.

Humboldt Bay Powerplant is located on the Pacific coast, approximately 165 miles north of San Francisco, about 3 miles south of Eureka. The unit was a 65-megawatt boiling water reactor which operated from 1963 to July 1976.

PG&E's selected method of decommissioning is custodial SAFSTOR for a period of up to 30 years; followed by DECON, or dismantlement of the unit. SAFSTOR was the only method of decommissioning available to PG&E, due to the presence of spent reactor fuel assemblies onsite and the lack of a spent fuel repository or reprocessing facility in this country.

Even though it was the only viable option, SAFSTOR had additional advantages. First, since unit 3 occupies a site with two operating fossil fuel units, the staff from those units will be available to perform necessary surveillance during SAFSTOR, and a custodial staff just for unit 3 will not be required.

Second, a 30-year SAFSTOR period will allow much of the radioactivity to decay, resulting in lower exposures when the unit is dismantled. It is estimated that total exposure after 30 years will be approximately one-fourth what it would be today.

Third, over the 30-year period, additional industry and decommissioning experience and developments and technology may simplify the process and result in lower final costs and exposures.

Projects such as the Shippingport decommissioning will be observed closely. The Shippingport plant is comparable both in age and in size to the Humboldt Bay unit 3, and much of its experience is expected to be applicable.

I recently attended a briefing at the Shippingport facility at which the information exchange program was described. PG&E will participate in this program and plans to use the information to update our plans for the final dismantlement of unit 3. Updates of projected costs are currently required every 3 years, and updates of decommissioning plans are required every 6 years by the California Public Utilities Commission.

In addition to cost information, demonstration of successful decommissioning techniques and information regarding radioactive waste processing and disposal will be extremely valuable in performing these updates.

Following PG&E's establishment of the decommissioning project team, planning sessions were held to establish schedule and cost estimates for the project. The following objectives were considered in the decommissioning planning:

To modify the plant facilities to support long-term storage of spent fuel, minimize generation of radioactive wastes, and minimize necessary maintenance and surveillance costs during SAFSTOR; to lay up nonoperating plant systems; to reduce general area radiation levels in the vicinity of equipment to be operated or maintained during the SAFSTOR period as low as reasonably achievable; to decontaminate plant facilities to the extent practical; to process and dispose of radioactive wastes remaining onsite at the beginning of SAFSTOR decommissioning and any waste generated during decommissioning; and to establish baseline conditions and a monitoring and surveillance program for the SAFSTOR period.

Prior to preparing the decommissioning plan for unit 3, a review was conducted of the decommissioning experience from other nuclear facilities such as the Plum Brook Reactor Facility, Peach Bottom unit No. 1, the proposed decommissioning plan for Indian Point unit No. 1, and the General Electric Vallecitos' nuclear facilities. This experience, together with project specific guidance from the NRC staff, formed the basis for Humboldt Bay unit 3's decommissioning plan.

Project costs of decommissioning unit 3 are approximately $14 million to place the unit into SAFSTOR; annual maintenance costs of $700,000 per year; and a final dismantlement of $54.8 million. The most significant component in both the SAFSTOR and final DECON cost is the processing and disposal of radioactive wastes. Changes in these costs as a result of surcharges and contact fees will significantly affect decommissioning costs.

On July 30, 1984, PG&E proposed to the NRC the amendment of the unit 3 license to "possess but not operate" status; deletion of certain license conditions related to seismic modifications; division of the technical specifications to reflect the possess but not operate status; decommissioning of Humboldt Bay unit 3 in accordance with the decommissioning plan submitted; and the extension of Humboldt's license for an additional 15 years—to November 9, 2015—to be consistent with the decommissioning plan.

On July 16, 1985, the NRC revised our Humboldt license to possess, but not operate, status. Presently, the staff has issued a draft environmental statement for the decommissioning of the Humboldt facility and is currently awaiting public comments.

The NRC also has under consideration the remaining license amendment requests for approval of the SAFSTOR plan and the decommissioning of the unit. Pursuant to NRC regulations, the public will have an opportunity to request a hearing with regard to these remaining license amendment requests.

Since January 1984, work has been ongoing to prepare unit 3 for the SAFSTOR decommissioning. This work has included unloading the reactor core; flushing, draining and securing nonoperating plant systems, and the processing and disposal of radioactive wastes. Upon NRC approval of the decommissioning plan and remaining license amendments the SAFSTOR decommissioning of the unit will be completed.

In preparation of the decommissioning plan, PG&E has performed safety studies to identify potential accidents and their consequences. The studies included evaluation of the effects of a seismic event as well as other events which might cause damage to the spent fuel or to the facility.

Primarily due to the long time since the plant was shut down, and the reduced decay heat being generated in the fuel, none of the events studied would result in a significant release of radioactivity from the facility.

The project to decommission Humboldt Bay unit 3 will demonstrate that custodial SAFSTOR is a viable option for the decommissioning of a commercial nuclear facility when it reaches the end of its useful life.

With regard to the funding of decommissioning costs: on September 19, 1983, PG&E filed its application with the California Public Utilities Commission to recover its unrecovered net capital investment in the Humboldt nuclear unit, and to collect the necessary decommissioning funds.

After hearings—which stretched over 2 years—on December 4, 1985, the commission authorized PG&E to collect, in an external fund, the necessary decommissioning funds over a 4-year period. The actual collection has been delayed pending regulations under the Tax Reform Act of 1984 which would set tax treatment of the funds.

On July 10, 1986, the Internal Revenue Service issued its temporary regulations governing nuclear decommissioning costs under the Internal Revenue Code. While PG&E has not had a chance to study fully the new regulations, it appears that approximately 50 percent of the Humboldt decommissioning cost will receive favorable tax treatment.

On January 1, 1986, the State of California's Nuclear Facility Decommissioning Act of 1985 became effective. Basically, that Act directs the establishment of external sinking funds for decommissioning cost estimates with the Public Utilities Commission, and a review of that cost estimate at each general rate case of the involved utility.

The statute specifically acknowledged the NRC's role in defining decommissioning activities, and requires that the fund be managed so as to qualify for the tax deductions pursuant to Internal Revenue Code, section 468A.

In conclusion, given the knowledge of SAFSTOR which Humboldt unit 3 will be contributing to the decommissioning of nuclear plants, PG&E is willing to accept technical and financial involvement from both the private and Government sectors.

Thank you.

[The prepared statement of Mr. Nelson follows:]

Statement of

ROBERT T. NELSON

Humboldt Bay Power Plant Unit No. 3
Decommissioning Project Manager

and

LOUIS E. VINCENT

Attorney

Pacific Gas and Electric Company

Before the Subcommittee on Investigations
and Oversight and the Subcommittee on Energy Research
and Production of the Committee on Science and Technology

U.S. House of Representatives

July 30, 1986

Mr. Chairman and Members of the Committee. My name is Robert T. Nelson. I am the Project Manager for the Decommissioning of Pacific Gas and Electric Company's Humboldt Bay Power Plant, Unit No. 3. With me today is Mr. Louis Vincent who will be available to answer any questions you may have regarding the regulatory recovery of decommissioning costs.

I appreciate the opportunity to address your Committee regarding decommissioning PGandE's Humboldt Bay Power Plant, Unit No. 3 which operated from 1963 to July 1976.

PGandE's selected method of decommissioning is custodial SAFSTOR for a period of up to 30 years followed by DECON (or dismantlement) of the unit. SAFSTOR was the only method of decommissioning available to PGandE due to the presence of spent reactor fuel assemblies on-site and the lack of a spent fuel repository or reprocessing facility in this country.

Even though it was the only viable option, SAFSTOR had additional advantages. First, since Unit 3 occupies a site with two operating fossil fuel units, the staff from those units will be available to perform the necessary surveillance during SAFSTOR and a custodial staff just for Unit 3 will not be required. Second, a 30 year SAFSTOR period will allow much of the radioactivity to decay resulting in lower exposures when the unit is dismantled. It is estimated that total exposure after 30 years will be 1/4 of what it would be today. Third, over the 30 year period additional industry and decommissioning experience and developments in technology may simplify the process and result in lower final costs and exposures.

Projects such as the Shippingport decommissioning will be observed closely. The Shippingport plant is comparable both in age and size to Humboldt Bay Unit 3 and much of its experience is expected to be applicable. I recently attended a briefing at the Shippingport facility at which the information exchange program was described. PGandE will participate in this program and plans to use the information to update our plans for the final dismantlement of Unit 3. Updates of projected costs are currently required every 3 years and updates of decommissioning plans are required every 6 years by the California Public Utilities Commission. In addition to cost information, demonstration of successful decommissioning techniques and information regarding radioactive waste processing and disposal will be extremely valuable in performing these updates.

Following PGandE's establishment of the decommissioning project team, planning sessions were held to establish schedule and cost estimates for the project. The following objectives were considered in the decommissioning planning:

- To modify plant facilities to support long-term storage of spent fuel, minimize generation of radioactive wastes, and minimize necessary maintenance and surveillance during SAFSTOR

- To layup non-operating plant systems.

- To reduce general area radiation levels in the vicinity of equipment to be operated or maintained during the SAFSTOR period to as low as reasonably achievable (ALARA)

- To decontaminate plant facilities to the extent practical to minimize the requirements for periodic surveys

- To process and dispose of radioactive wastes remaining on-site at the beginning of SAFSTOR decommissioning activities and any wastes generated during decommissioning

- To establish baseline conditions and a monitoring and surveillance program for the SAFSTOR period

Prior to preparing the decommissioning plan for Unit 3, a review was conducted of the decommissioning experience from other nuclear facilities such as the Plum Brook Reactor Facility, Peach Bottom Unit No. 1, the proposed decommissioning plan for Indian Point Unit No. 1, and the General Electric Vallecitos' nuclear facilities. This experience together with project specific guidance from the NRC staff formed the basis for Humboldt Bay Unit 3's Decommissioning Plan.

The project costs of decommissioning Unit 3 are approximately $14 million to place the unit into SAFSTOR, annual maintenance costs of approximately $700,000 per year and a cost of final dismantlement of $54.8 million (all figures are in 1984 dollars). The most significant component in both the SAFSTOR and final DECON costs is the processing and disposal of radioactive wastes. Changes in these costs as a result of surcharges and compact fees will significantly affect decommissioning costs.

On July 30, 1984, PGandE proposed to the NRC: (1) amendment of the Unit 3 license to a possess but not operate status, (2) deletion of certain license conditions related to seismic modifications, (3) revision of the technical specifications to reflect the possess but not operate status, (4) decommissioning of Humboldt BAy Unit 3 in accordance with the plan included with the submittal, and (5) extension of Humboldt's license (DPR-7) for 15 additional years to November 9, 2015, to be consistent with the decommissioning plan. On July 16, 1985, the NRC revised our Humboldt license to a possess but not operate status. Presently, the staff has issued a draft environmental statement for the the decommissioning of the Humboldt facility and is currently awaiting public comments which are due to be filed no later than August 16, 1986. The NRC also has under consideration the remaining license amendment requests for approval of the SAFSTOR plan and the decommissioning of the unit. Pursuant to NRC regulations the public will have an opportunity to request a hearing with regard to these remaining license amendment requests.

Since January 1984, work has been ongoing to prepare Unit 3 for SAFSTOR decommissioning. This work has included unloading the reactor core; flushing, draining and securing non operating plant systems and the processing and disposal of radioactive wastes. Upon NRC approval of the Decommissioning Plan and remaining license amendments the SAFSTOR decommissioning of the unit will be completed.

In preparation of the decommissioning plan, PGandE has performed safety studies to identify potential accidents and their consequences. The studies included evaluation of the effects of a seismic event as well as other events which might cause damage to the spent fuel or the facility.

Primarily due to the long time since the plant was shut down and the reduced decay heat being generated in the fuel, none of the events studied would result in a significant release of radioactivity from the facility.

The project to decommission Humboldt Bay Unit 3 will demonstrate that Custodial SAFSTOR is a viable option for the decommissioning of a commercial nuclear facility when it reaches the end of its useful life.

FUNDING OF DECOMMISSIONING COSTS

On September 19, 1983, PGandE filed its Application with the CPUC to recover its unrecovered net capital investment in the Humboldt Nuclear Unit, and to collect the necessary decommissioning funds. After hearings which stretched over two years, on December 4, 1985, the Commission authorized PGandE to collect in an external fund the necessary decommissioning funds (estimated $58 million expressed in 1986 dollars) over a four-year period. The actual collection has been delayed pending regulations under the Tax Reform Act of 1984 which would set tax treatment of the funds.

On July 10, 1986, the Internal Revenue Service issued its Temporary Regulations governing nuclear decommissioning cost under the Internal Revenue Code. While PGandE has not had a chance to study fully the new regulations, it appears that approximately 50% of the Humboldt decommissioning cost will receive favorable tax treatment.

On January 1, 1985, the State of California's Nuclear Facility Decommissioning Act of 1985 became effective. Basically, that Act directs the establishment of external sinking funds for decommissioning cost estimate with the Public Utilities Commission, and a review of that cost estimate at each general rate case of the involved utility. The statute specifically acknowledged the NRC's role in defining decommissioning activities, and requires that the fund be managed so as to qualify for the tax deductions pursuant to Internal Revenue Code, Section 468A.

In conclusion, given the knowledge of SAFSTOR which Humboldt Unit 3 will be contributing to the decommissioning of nuclear plants, PGandE is willing to accept technical and financial involvement from both the private and government sectors.

Mr. **Volkmer**. Thank you very much, Mr. Nelson.

I will recognize the gentleman from California for any questions you may have.

Mr. **Packard**. Thank you, Mr. Chairman.

Again, I am grateful to have two California witnesses today. I appreciate them coming.

Mr. Nelson, I believe that the size of Humboldt Bay is fairly close to the size of Shippingport; is that correct?

Mr. **Nelson**. Yes, that is correct.

Mr. **Packard**. Why are your estimates of decommissioning, even going into a 30-year interim period holding pattern—why is it coming in quite a bit lower than Shippingport, when Shippingport has, according to earlier testimony, has things already done to it that would reduce its costs from what normal decommissioning would require?

Mr. **Nelson**. I have not analyzed the details of the Shippingport cost estimate. I do know that Shippingport is being performed as a demonstration project with certain aspects such as the Information Transfer Program and the use of as many subcontractors as possible, which would be different than the way we would most likely handle the Humboldt decommissioning.

Our cost estimate was done some time before the Shippingport cost estimate. But some of those factors may have affected it.

Mr. **Packard**. $80 million versus about $100 million.

Your cost estimates, do they take into consideration the 30-year—the dollars, 30 years from now?

Mr. **Nelson**. Our cost estimates were actually performed—Mr. Vincent might correct me on the year—but, I believe, in 1979.

Mr. **Packard**. It was in 1979 that——

Mr. **Nelson**. They have been escalated to the 1986 dollars for the figures I have given you today.

Mr. **Packard**. OK.

When did Humboldt or PG&E start to formulate their decommissioning plan?

Mr. **Nelson**. We started formulating the plan in July 1983, shortly after we announced the decision to decommission the unit.

Mr. **Packard**. When will it actually be put in your SAFSTOR?

Mr. **Nelson**. The actual decommissioning cannot be performed until the NRC approves our decommissioning plans; when that will occur is subject to whether or not public hearings will be required to be held before they approve our plans.

Mr. **Packard**. Do those delays create an additional cost to you?

Mr. **Nelson**. I am sorry, could you repeat——

Mr. **Packard**. Do those delays, waiting upon NRC, does that create additional costs to you in your plan?

Mr. **Nelson**. Depending on the extent of the delays, it could, yes.

The dates that I gave you was the length of time until we can complete the decommissioning, to place the unit into SAFSTOR. The final dismantlement, decommissioning will not be completed until some time during the period of up to 30 years.

Mr. **Packard**. What reason would cause you to bring it out of the SAFSTOR before the 30-year period and start to dismantle?

Mr. **Nelson**. If the availability of a repository for the spent fuel comes about and the fuel is shipped off-site, then the decision could be made before the end of the 30-year period to dismantle at a sooner date.

Mr. PACKARD. And when did you start to set aside funds?

Mr. NELSON. I have to let Mr. Vincent answer that question.

Mr. VINCENT. We are setting aside decommissioning funds. We initially started, just as part of the depreciation reserve, as has been testified to earlier, and then when we came up with the plan in 1979. But as of today no funds are actually set aside because the commission has given us the order to set aside, but we need to calculate the precise number and are waiting for the Tax Reform Act, and also some questions regarding the trust fund, the trust document itself.

Essentially, we could have started January 1, 1986, with those clarifications.

Mr. PACKARD. How do you plan to raise the funds when the plant itself is not functioning?

Mr. VINCENT. There will be a ratepayer contribution, over a 4-year period. For two reasons, primarily: The plant was used and useful and, therefore, it is cost to the ratepayers. Second, it was based on an estimated life, and the ratepayers and the equity system. We have 80 plants, some which exceed their useful lives, some which don't match their useful lives and the ratepayers get the benefits of the ones which have outlasted their useful lives as well. So it was a ratepayer expense since the plant was, in essence, used and useful.

Mr. PACKARD. This may be a hypothetical situation, but what would happen if you had no other nuclear plants in service with PG&E, if this were the only one, and you were in the circumstances as with Humboldt now, where you had no collection of funds during operation; would that mean that the ratepayers in your service district would pay—they would still have to pay it; wouldn't they, they are the only source you have?

Mr. VINCENT. That is right.

That was essentially the case when Humboldt went off-line because we had no other nuclear units in PG&E service territory online then——

Mr. PACKARD. I see.

Mr. VINCENT [continuing]. And the CPUC—California Public Utilities Commission—reviewed it, and in the course of the 2-year hearings, found it reasonable that the direct and the cost of decommissioning be a ratepayer expense.

Mr. PACKARD. What were the reasons for discontinuation of Humboldt service after 13 years, approximately; how long was it commissioned for?

Mr. NELSON. The plant had an original lifetime, or original license, that went to the year 2000.

Mr. PACKARD. What was the reason for closing early?

Mr. NELSON. It was shut down in July 1976 for refueling, maintenance, and additional seismic studies that were directed by the Nuclear Regulatory Commission. While those studies were ongoing the accident occurred in Three Mile Island, which resulted in many new regulatory requirements for all operating nuclear plants.

It became obvious very shortly that it would be very expensive for Humboldt to upgrade the plant, considering its small size and short remaining lifetime, and to upgrade to all these new requirements. So, in 1983, it was basically an economic decision that it would not be economical to restart the unit.

Mr. PACKARD. In your judgment, Mr. Nelson, how do decommissioning risks compare with operating risks of nuclear plants?

Mr. NELSON. Decommissioning risks are much, much lower than operating risks, primarily due to the much lower levels of radioactivity existing at the plant site, and the length of time since the reactor was shut down. So the radioactivity is in a much less volatile form.

For example, our spent fuel in our reactor spent fuel pool no longer even requires to be cooled by water. If all of the water were lost out of the pool, due to some accident, the fuel could adequately cooled by air. So we don't need the systems that an operating plant would need to keep your fuel cool.

Mr. PACKARD. Does PG&E plan to handle their spent fuel and their core reactor the same way as Shippingport; in other words, in once piece; or do they plan to cut it up into pieces?

Mr. NELSON. The original decommissioning estimate, which was done before the Shippingport project, was based upon cutting up the reactor vessel into pieces. But when we wrote our decommissioning plan, and that included a proposed dismantlement plan to the NRC, we mentioned that at the time of 30 years from now, we would evaluate experience and radiation levels, and the reactor vessel itself, and it may well be able to be taken out in a single unit.

Mr. PACKARD. Will Shippingport be of particular interest to you in that respect; is it about the same size in terms of whether it requires cutting up or whether it could be done in one piece?

Mr. NELSON. Reactor vessel size is very similar to ours, yes.

Mr. PACKARD. Do you think the industry has sufficient knowledge in terms of cutting technology?

Mr. NELSON. Yes, I do.

Mr. PACKARD. I don't know whether we can get through with Mr. Papay.

Mr. VOLKMER. Do you have any more questions for Mr. Nelson?

Mr. PACKARD. I wanted to finish his before we went to vote.

Mr. VOLKMER. Do you have any more for Mr. Nelson?

Mr. PACKARD. What method of decommissioning—let me pass that one up.

Mr. VOLKMER. To carry on the line of questioning Mr. Packard has, but I would just like to intervene in here and just say that it appears that, Mr. Nelson, that you all, Pacific, and also Southern California are looking to Shippingport, to kind of demonstrate to you, the method of doing the decommissioning; is that correct or am I incorrect in that?

Dr. PAPAY. That is correct from our perspective.

Mr. NELSON. From our perspective, also. In addition to demonstrating the technology and techniques, we are looking to get information and data from them, to be able to use as a basis for support in our plans.

Mr. VOLKMER. How do you plan to obtain that information and data; do you have it ongoing right now?

Dr. PAPAY. There are several ways I think the data will become available. DOE does have a Technology Transfer Program that they are going to put into place. And I think we will get the data from them and through industry committees such as the AIF, the Electric Power Research Institute, and EEI. Plus, the vendors that will get the experience at Shippingport are likely to be the vendors who are to be involved decommissioning other plants throughout the country.

Mr. VOLKMER. Do you have anything to add to that, Mr. Nelson?

Mr. NELSON. No; I agree.

Mr. VOLKMER. Mr. Vincent.

Mr. VINCENT. No; I agree, sir.

Mr. VOLKMER. OK. With that, I think we will go ahead and vote, and then we will be back. We will conclude after this next vote.

Thank you.

[Recess.]

Mr. VOLKMER. I will now recognize the gentleman from California for any additional questions he may have.

Mr. PACKARD. Thank you; I do, Mr. Chairman.

Mr. Papay, the operating license for San Onofre No. 1 expires in the year 2004, as I recall?

Dr. PAPAY. That is correct.

Mr. PACKARD. Is there a chance that the facility will be shut down before that time; and what are the chances of seeking an extension of the use of it beyond 2004?

Dr. PAPAY. The answer to that is, at this point in time, we fully expect the plant to be able to operate, to the end of this current license, which would be the year 2004. Obviously, as we get closer to that point in time, we will evaluate from a technical point of view, looking at the equipment, and what would need to be refurbished, as to whether it would make economic sense, to extend the life of that unit beyond that point in time.

If it made economic sense for the ratepayers then we would go back to the NRC and get an extension to the license for some period of time.

Mr. PACKARD. Was it relicensed once before?

Dr. PAPAY. No; it is on its original license.

Mr. PACKARD. On its original license?

Would you please explain the decommissioning requirements, imposed by the California Public Utilities Commission, and how these requirements differ from other states? Also, in your testimony, you indicated that the Palo Verde plant is a joint—two States involved there, how will California's PUC and other States PUC's affect, not only your situation, but other companies that might cross State borders?

Dr. PAPAY. OK. In the case of—let me go back by way of reference to San Onofre. Since San Onofre is within California and its ownership is California Utilities, it falls totally under—except for our municipal partners—as far as the private members, it falls under the jurisdiction of the California Public Utilities Commission 100 percent.

They have set up requirements for us to build up the depreciation reserve for decommissioning. At this point in time, for San Onofre unit 1, we have collected $32 million for decommissioning.

That was as of this morning, maybe since this hearing has gone on, we may have gotten another million.

Mr. **Packard**. How long has that collection process been?

Dr. **Papay**. That has gone on since the late 1970's, for San Onofre unit 1. For units 2 and 3, since they just came on in 1983 and 1984, the combined reserve there is in the order of $13 [77] million, at this point in time.

It was mentioned that we will be moving from an internal reserve to an external fund, because of the law which has been passed. Again, this will be under the jurisdiction of the California Public Utilities Commission.

The decommissioning costs and plan for Palo Verde are in the process of being developed. It is not totally clear how that will be handled. My presumption, at this point in time, is once the decommissioning costs are established for Palo Verde, since we are about a 16-percent owner in in Palo Verde, we will pick, and be allowed, to collect in an external fund, approximately 16 percent of the costs of decommissioning for the units at Palo Verde.

Mr. **Packard**. Will those collections and set asides, that 16 percent, be from your ratepayers, or will it be from the service area of Palo Verde?

Dr. **Papay**. It would be from our ratepayers. Then it would be up to the commissions in the State of Arizona and New Mexico and Texas, all of which have utilities with ownership, to ensure that on a proportional basis the ratepayers there pick up their proportional share of the costs. One complicating factor; I mentioned we have two municipals involved in San Onofre units 2 and 3, the cities of Anaheim and Riverside; and there are public entities, for instance, not investor-owned utilities involved in Palo Verde; and there are some commercial nuclear units that are owned by municipal utilities, these do not fall under State commission regulations. So depreciation reserves for utilities such as those, in essence, do not exist, and it is up to the local municipalities or governmental bodies, REA's and other entities such as that, to handle a depreciation account. We, in essence, have a PUC which serves as a watchdog and, of course, the NRC is the watchdog watching the watchdog.

Mr. **Packard**. You indicated that somewhere around 1970 or 1972 you started to set aside funds for unit 1 at San Onofre?

Dr. **Papay**. Well, we were getting depreciation right from the time it started in 1968, but we got into a heavy reserve in the late 1970's.

Mr. **Packard**. All right.

Under what plan did you start setting aside the funds in the late 1970's?

Dr. **Papay**. This was under a plan approved by the California Public Utilities Commission to set up a depreciation reserve. It was on this negative-net-salvage basis, and it was based upon a decommissioning study which we had performed by a consultant to estimate the costs of decommissioning for unit 1.

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[77] Dr. Papay changed "13" to "18".

Mr. **Packard**. Did the State of California move forward on this issue before many of the other States and before DOE and NRC?

Dr. **Papay**. I can't speak in terms of other States. I have a feeling it was fairly early in the game, and it did precede the NRC rulemaking process.

Mr. **Packard**. In your testimony you indicated that in 1976 you retained an independent consultant to help prepare your decommissioning cost estimates for unit 1; did Southern California Edison begin—no, let me restate.

You mention that funds are now being set aside for unit 2 and 3, you have a cost line for each of those that is different; what are the differences between your estimated costs of units 1, 2, and 3, why do they differ?

Dr. **Papay**. OK, unit 1 differs simply because it went in a lot earlier and it is an entirely different machine, so to speak, than units 2 and 3. The reason units 2 and 3 differ in their estimates—and it is a very good question because they are identical units.

Mr. **Packard**. They are identical.

Dr. **Papay**. Certain facilities would have to stay in operation with unit 3 even though you shut down and started to decommission unit 2. The spent fuel storage facility would have to stay in operation with unit 3.

So, the decommissioning costs associated with that unit are correspondingly higher because certain portions of the common facilities would have to stay in operation.

Mr. **Packard**. What does your current plan hold for decommissioning 2 and 3; would it be the same plan as 1, in terms of selecting one of the three options such as dismantling immediately?

Dr. **Papay**. With all three units at San Onofre, we are planning to do the immediate dismantlement of the units following shutdown.

There are several reasons for this, one of them being economic. But second, we are tenants of the Federal Government at San Onofre, since it is on Camp Pendleton, and we have an obligation to return the property to the landlord.

Mr. **Volkmer**. They don't have to renew that license——

Mr. **Packard**. That is a good point the chairman brings up. Then you are not intending to extend your license on those, or at least you are not planning to at this point?

Dr. **Papay**. We have not made a final determination as far as license extension on those units. Obviously, to be able to do that, we would have to go back to the Defense Department, the Marine Corps, to ensure that we would be able to extend the license.

Mr. **Packard**. The IRS, as you know, has made recent temporary regulations detailing how nuclear utilities can deduct cash payments for decommissioning and set-asides; what does that—how does that decision impact the decommissioning funding method chosen by your company?

Dr. **Papay**. It has not created a problem under the method which we are using at this point in time. But as was mentioned by the other testimony, with the creation of the external fund, there is now being sought a ruling from the IRS relative to the tax treatment under the external fund approach. We will be required to switch to the external fund approach once the procedures are in place.

We would be impacted in exactly the same manner—I guess, that currently it is viewed that 50 percent would be exempt from taxation.

Mr. PACKARD. Mr. Nelson, does your company have—how do you feel about the decision by IRS?

Mr. NELSON. I would like to defer that to Mr. Vincent, if I can.

Mr. PACKARD. Yes.

Mr. VINCENT. Mr. Packard, actually it has been a help. We haven't been able to implement it yet because we are awaiting the regulations in the case of the Humboldt, inactive plant.

But in terms of decommissioning our other plants, it has been very helpful because we know what the tax consequences will be; there is a positive incentive to accumulate those funds at the front end, and we think it is going to be advantageous. Once the IRS works out just the logistics of the fractions and the percentages, I think it would be very beneficial to encouraging decommissioning.

Mr. PACKARD. Mr. Vincent, have you reviewed the new tax proposal to determine how it addresses this issue?

Mr. VINCENT. No, sir, I have not.

Mr. PACKARD. Anyone, do you know if, in fact, it has any implications at all on the temporary regulations issued by the IRS?

Dr. PAPAY. No, I do not.

Mr. PACKARD. What flexibility do your utility companies have with the funds that are set aside?

I know that—I believe that—Ms. Pollock, I believe, in her testimony she indicated that she would like to see more restrictions on the use of those funds.

What are the restrictions on those funds; what can you do with them; and how are the ratepayers assured that they will be available at the time of decommissioning?

Mr. VINCENT. Basically, there are two forms of the rules, one coming from the California Public Utilities Commission itself, and then the California legislation. But both are premised on external trust funds. So, it is a trust. The funds are available. The purpose of the trust is solely for decommissioning.

The investment decisions are to be monitored by the commission itself. The commission is to have a role in appointing the advisors. The trustee will consist of one of the large and well-recognized banks, Security Pacific, Wells Fargo, someone of that nature.

The precise definition of the investment strategies has not been worked out. We are proposing that is subject to an annual review by the part CPUC.

The last standard that was explored was that of the black lung trust fund standard. In other words, the investments would only be as secure, or would work within the same constraints, that has been found workable for that particular fund.

The main problem, the reason there is a bit of hesitation is, as I say, the final trust document has not been drawn up. But those are the principles that it will try to match.

Mr. PACKARD. Do you feel comfortable with that type of rule; or would you prefer more flexibility?

Mr. **Vincent**. Other than the monetary difference that has been alluded to earlier, the external fund should work very well in that it is on the trust principle.

The other factor is, because we are talking in some cases up to 30 years out, or in some cases we are talking in part procedures that haven't been demonstrated 100 percent, what we have in California is a procedure whereby every 3 years our cost estimates will be reviewed, the investment strategies, the return on the trust, and then every 6 years review, in particular, our Humboldt decommissioning plan: are we looking at the appropriate labor rates; have we taken technology and the latest regulatory pronouncements into account?

So, it is recognized by the parties in charge, as well as the company, that we have a bit of a moving target and that we have to adjust, adjust accordingly.

Dr. **Papay**. I think that is an important point just to add on, that we do the update reviews of cost estimates and can go back and make modifications based upon the flow of information, technology and cost estimates.

Mr. **Packard**. You have the option under, at least the proposed rules, to go with the base, with the generic base, $100 million in 1984 dollars—plan, or on a facility-specific plan; which would you choose, Mr. Papay?

Dr. **Papay**. Well, as I mention, we do site-specific planning, and we find it to be particularly important in our case, because of the seismic design at San Onofre and the very tight site configuration that we have. The generic approach gives you generic numbers and, unfortunately, they don't apply to specific cases.

Mr. **Packard**. Being torn between higher rates versus not having adequate funds at the time of decommissioning, where would your company prefer to be?

Dr. **Papay**. Although I hate to say I propose or espouse higher rates, when you look at what is required in terms of annual dollars to build up the decommissioning reserve, it is really a small fraction of our total revenue base. I think it is more important to set aside the appropriate amount of funds so that in the last year or years of operation, or even after you have started decommissioning, you are not trying to go back, as in the case of Humboldt Bay, for example, and extract more money for a plant that is now out of service. It is a lot better to build an adequate reserve before the fact.

Mr. **Packard**. Every time you ask for a rate increase you have go before your State PUC?

Dr. **Papay**. That is correct.

Mr. **Packard**. Have they been cooperative; have they been sensitive to the need for set-aside funds; or have they given you any problems in terms of asking for rate increases to accommodate the set-aside funds for decommissioning?

Dr. **Papay**. I would contrast [78] the state public utilities commission as being extremely cooperative in this manner. We don't necessarily see exactly eye-to-eye on every issue. But they recognize the particular needs for nuclear plant decommissioning reserves to be built up.

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[78] Dr. Papay changed "contrast" to "consider".

Unfortunately, in contrast to that we find that the FERC jurisdiction is much more complicated and does not recognize the full needs for decommissioning.

Mr. VOLKMER. Would the gentleman yield on that?

Mr. PACKARD. I am through with my questions. I would be happy to yield.

Mr. VOLKMER. Your last statement concerned me, then. You do have to go before FERC, you do do some wholesale?

Dr. PAPAY. About 7 percent of our revenues.

Mr. VOLKMER. Is wholesale?

Dr. PAPAY. Yes.

Mr. VOLKMER. You do go to FERC?

And what has FERC given you, a 100?

Dr. PAPAY. FERC is giving us about 40 percent of our request. In other words, they have used the generic approach to come up with a number.

Mr. VOLKMER. You use the same site-specific figures, data, and information, everything, that you used before the California Public Utilities Commission?

Dr. PAPAY. That is correct.

Mr. VOLKMER. You went to FERC, used the same thing, and got 40 percent less, based on their using generic?

Dr. PAPAY. That is correct.

Mr. VOLKMER. I want to make a note of that.

Now, Mr. Nelson, assuming that we had a permanent repository for spent fuel, would PG&E have adopted in a different policy, do you think; or do you want to comment on it?

Mr. NELSON. I can't say we would have adopted a different policy; I say we would have had more options——

Mr. VOLKMER. You would have had an option to look at other than the one that you did have?

Mr. NELSON. That is correct.

Mr. VOLKMER. You didn't, of course, make any cost estimate for immediate decommissioning, based on the fact that you just didn't have that option?

Mr. NELSON. That is correct.

Mr. VOLKMER. What have you planned so far—we know you have been approved for a 30-year storage—what are your plans after the 30 years; have you got anything underway or are you going to wait 10 years out before you make your decommissioning plan?

Mr. NELSON. Well, we are required to update our—first, we filed, along with our decommissioning plan, a proposed very, very general dismantlement plan with the Nuclear Regulatory Commission. Per the proposed rulemaking, I anticipate that at some period of time prior to the actual dismantlement we will have to file with them a final dismantlement plan.

Mr. VOLKMER. All right.

Mr. NELSON. That will be done prior to the end of the 30-year period. Also, the public utilities commission requires us to have updates of our decommissioning plans every 6 years.

Mr. VOLKMER. All right.

Now, as I understand it, one of the things that is helping in your cost are the fact that you have one or two fossil fuel plants, right adjacent to the Humboldt Bay plant; is that correct?

Mr. **Nelson**. That is correct, we have two units.

Mr. **Volkmer**. Two units.

Were those constructed prior to or subsequent to construction of the Humboldt Bay?

Mr. **Nelson**. Prior to the nuclear unit.

Mr. **Volkmer**. Prior to the nuclear.

I am just thinking, sitting here, I don't know, Dr. Papay, maybe you can comment on this. If we get to the point, say, 15 years from now, and you are still 10 years or 15 years out from whether you are going to have to decommission, and you are looking at your energy demand, where it is going to be, and you say, "We are going to have to pull these out, and what are we going to put in it;" if you put a fossil fuel plant adjacent to them, then, as I understand from Mr. Nelson's testimony, your costs of SAFSTOR go way down because your people that are running the fossil fuel plant can do the SAFSTOR; is that correct, Mr. Nelson?

Mr. **Nelson**. That is correct, yes, the surveillance.

Dr. **Papay**. Yes, you would not have people dedicated solely to the SAFSTOR approach because you could handle as part of an existing site.

Mr. **Volkmer**. Right.

Dr. **Papay**. So, if it was licenseable in the sense of being able to put fossil units where you had nuclear units that were going out of service, then that would improve the SAFSTOR concept economics; that is true.

Mr. **Volkmer**. Right.

Mr. **Packard**. Would the gentleman yield?

Mr. **Volkmer**. Yes, I yield on that.

Mr. **Packard**. Then, Dr. Papay, why is Southern California Edison considering immediate decommissioning of unit 1, instead of going into SAFSTOR for the same economic reasons; aren't there also two other units there?

Dr. **Papay**. Two other units. And as we get closer we would probably still go with dismantling.

We might stretch the dismantling over a longer period of time to fit in the workload, considering the fact that we would, in fact, have two operating units sitting side by side to unit 1, which would have been shut down. So, the rate at which we dismantle unit 1 could be stretched over a longer period of time.

It wouldn't be the same sense of urgency, if you were, at the conclusion of that, going to have a virgin site; [79] so that is true.

Mr. **Volkmer**. On Humboldt Bay I assume that you have had a radiation survey of the full site?

Mr. **Nelson**. Yes, we have.

Mr. **Volkmer**. Do you have available the levels of activated materials that were in the reactor?

Mr. **Nelson**. We have studies that have estimated the levels of activation of the reactor vessel and the core components around the vessel. The activated materials are restricted just to the reactor vessel and drywall.

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[79] Dr. Papay changed this sentence to read: "It wouldn't be the same sense of urgency as if you were at the conclusion of that going to have a virgin site."

Mr. VOLKMER. Would it be too much difficulty for you all to furnish us copies of that on the activated material?

Mr. NELSON. No, we could do that.

Mr. VOLKMER. The cost estimates that you both used—first of all, have you all seen the guidelines that were described by Dr. Levy, that AIF had developed in decommissioning, in cost?

Mr. NELSON. I personally have never seen them; no.

Mr. VOLKMER. Dr. Papay.

Dr. PAPAY. Personally, no. But we have had people involved in that committee, so we have used them and we are aware of them.

Mr. VOLKMER. Well, that is what my question is, did you use any of these guidelines in the preparation of your costs; if not, do you plan to examine them, to look at them, because you are going to have to be reevaluating in about 2 years or 1 year?

Dr. PAPAY. Yes, and yes.

Mr. VOLKMER. Now, on Palo Verde, you are 16 percent?

Dr. PAPAY. That is correct.

Mr. VOLKMER. So we know supposedly we will get 16 percent of decommissioning; how will we know if we are going to get the other 84 percent?

Dr. PAPAY. That is a very good question, because if you look at the ownership at Palo Verde it is fairly complicated in the fact that there are——

Mr. VOLKMER. You mention municipals.

Dr. PAPAY. There are seven entities that have ownership interest in Palo Verde, four of them are investor-owned utilities, each of which exist in a different State. So those four investor-owned utilities will be required to have their public utility commission——

Mr. VOLKMER. They will have to go to their public utility commission, each individual?

Dr. PAPAY. That is correct.

The other three entities are public agencies, the Salt River project, the Los Angeles Department of Water and Power, and a group of southern California municipal utilities called SCAPA.

Mr. VOLKMER. They are not under any regulatory body?

Dr. PAPAY. They are not under any regulatory body; that is correct.

So, they have to come up internally with a method of establishing a decommissioning reserve. There is no oversight regulatory body for them.

Mr. VOLKMER. At the time that there was an agreement to construct Palo Verde 1, 2, and 3, there was nothing put in the agreement——

Dr. PAPAY. Relative to decommissioning; I couldn't answer that specifically.

Mr. VOLKMER. Sometime would you have someone with the southern California attorneys let us know about that——

Dr. PAPAY. We will provide an answer to that.

Mr. VOLKMER [continuing]. Because if it is not, then I think that is something that we in the Congress are going to have to look at due to the fact that we have many other power sources, powerplants that are probably in the same position.

Dr. Papay. Yes.

Mr. Volkmer. We are going to come down the line where we are going to have maybe 30 or 40 percent of the funds, but not sufficiently 100 percent of the funds. And the question is who would have the authority to say, "Now, you are not going to be able to sell the other ones, you have got to come the rest of the money;" unless it is somewhere in the agreement?

Dr. Papay. We will provide some comments on that; we have to look at the contract.

Mr. Volkmer. Dr. Papay, if, say, one, or two, or three of the San Onofre units were to be closed for some reason; how would you pay for the decommissioning if they were closed early?

Dr. Papay. We would have to go back to the public utilities commission and look for some incremental rate treatment to beef up the decommissioning accounts so that we could accomplish that.

Mr. Volkmer. The utility itself would not have the funds available?

Dr. Papay. We would go back and attempt to get the funds from the public utility commission since the machine had been used and useful for the benefit of the ratepayers, in a manner analogous to what has been done on Humboldt Bay.

Mr. Volkmer. In discussing earlier with our previous witness, I brought up the question of nuclear-power companies developing their own low-level waste sites; what do you think of that?

Dr. Papay. It is a novel approach. We have been precluded simply by law. It was left to the States.

I guess one could make the argument that we are deep pockets anyway, so even if we give our waste to a State-licensed facility somebody can always trace us back to it, and that may be one way to assure that the waste are handled in a proper manner.

Mr. Volkmer. It is something that is not—in other words, it wouldn't be completely objectionable to you to examine?

Dr. Papay. I think it is worth taking a look at.

Mr. Volkmer. Mr. Nelson, do you have any comment you would like to make on that; or Mr. Vincent?

Mr. Nelson. I really don't have any additional comments on it that; no.

Mr. Vincent. The only comment I would make, Mr. Chairman, and just thinking about it very initially. I know the Federal Government has security interest in all nuclear waste, and in the late 1970's, as a matter of fact, changed the reprocessing format.

So that would be would one concern, if I were going to look at this more. I would look at very closely to see to what extent the Government wants to handle this——

Mr. Volkmer. Of course, we are talking about only low-level?

Mr. Vincent. Yes; I recognize that, sir, that is why I would have to study it further.

Mr. Volkmer. Now, we are going to have San Onofre and Humboldt Bay, Palo Verde, all of them, none of them are really going to be decommissioned until after the year 2000, everybody agree on that?

Dr. Papay. Yes.

Mr. Vincent. Yes.

Mr. Nelson. Yes.

Mr. Volkmer. And how much documentation are we going to have available through the corporations, whoever it may be, that comes in to clean them up?

Mr. Nelson. This is one thing that is addressed in the NRC rulemaking, that they are going to require a set of as-built drawings for all the nuclear facilities, as well as records of any operational events that occurred during the operating life of the plants to be used as a data base when final dismantlement is occurring.

Now, in the case of Humboldt Bay, which, of course, was operated before the proposed rule was even written, one of our goals at the completion of the decommissioning project will be to create this kind of data base, as well as a report of what we have done to date on the SAFSTOR decommissioning to be used for the final dismantlement.

Mr. Volkmer. Dr. Papay?

Dr. Papay. I would simply second what Mr. Nelson said; the requirements and the proposed rulemaking are such that there is going to be a rather complete set of drawings and data available at the time of decommissioning.

Mr. Volkmer. I have no further questions.

Does the gentleman from California have any?

Mr. Packard. Just one more, Mr. Chairman, to Dr. Papay.

Unit 1, again, getting back to the cost estimates, was $137 million, unit 2, $149 million, and unit 3, $169 million. How many megawatts is unit 1?

Dr. Papay. 436.

Mr. Packard. And two is about 1,100?

Dr. Papay. Yes; two and three are each about 1,100.

Mr. Packard. So they are both about 1,100.

So they are over double?

Dr. Papay. That is correct.

Mr. Packard. Each of units 2 and 3 are over double No. 1, but unit 2 is only $10 million more to dismantle?

Do you think that general pattern will follow that the size, in terms of megawatts, will not have a significant increase in cost from one plant to another; that there are factors that are more important than the total number of wattage?

Dr. Papay. That is correct. If you look at unit 1 and units 2 and 3, as far as the type and number of each piece of equipment or components, they are very similar.

The only difference is some components are larger, or you have more of them in one case than another, but piping diameters are even quite similar.

The radiation history will be essentially the same because both will be operating for extended periods. So, there are certain scaling factors, but really it is the amount of massive material that you have there and you have to dispose of.

Mr. Packard. Thank you, Mr. Chairman.

Mr. Volkmer. Thank you.

I wish to thank the witnesses for being here and taking most of your day. I appreciate it very much. You have been very helpful.

With that, the hearings will adjourn.

[Whereupon, at 3:25 p.m., the hearing adjourned.]

APPENDIX

Material Submitted for the Record by Other Parties

Union Electric
1901 Gratiot Street, St Louis

July 28, 1986

The Honorable Harold L. Volkmer
Chairman, Subcommittee on
Investigations and Oversight
Room 2321, Rayburn House Office
Building
Washington, D.C. 20515

Dear Harold:

Thanks for your letter of July 10 inviting us to participate in the July 30 joint hearing on the Department of Energy's plans to decommission the Shippingport reactor.

Unfortunately, as I explained to your staff assistant, James Paul, we will not be able to be with you because July 30 is the date on which we will conduct our mandatory annual emergency response drill at Callaway Plant under the watchful eye of the Nuclear Regulatory Commission and the Federal Emergency Management Agency. Virtually all of our nuclear management, engineering and technical personnel have been deeply involved in preparing for this event over the past several months or so and will be active participants in the drill on the 30th.

With respect to the issue of decommissioning Callaway Plant, I'm enclosing a copy of the testimony and studies of our expert witnesses and the Missouri Public Service Commission Staff from the 1985 Callaway rate case. The Stone and Webster Engineering Corporation study contains a thorough and detailed review and evaluation of the currently available alternatives for decommissioning Callaway, together with a technical assessment and estimated cost of each alternative.

The only "special actions" being undertaken with respect to decommissioning Callaway Plant that may be of interest involves the creation of a separate external trust fund to collect and hold decommissioning money collected from ratepayers. During the Callaway rate case, we proposed using the net negative salvage method to cover decommissioning since that method results in the least cost to our customers. The PSC

The Honorable Harold L. Volkmer
Page 2
July 28, 1986

staff insisted upon setting up an external fund under the custodial care of an independent trustee. In its March 29, 1985 rate order, the Commission agreed with Staff and we have since designated Centerre Trust Company of St. Louis to serve as trustee of a separate independent fund to collect and hold Callaway decommissioning costs. A copy of the pages from the Commission's Report and Order covering the decommissioning issue are also enclosed.

Again, we regret that we cannot be with you on July 30. Please don't hesitate to call if you or your staff have any questions or need further information.

Best regards.

Sincerely,

Joseph E. Birk

Joseph E. Birk

JEB:mm
Enclosures
cc:w/o Enclosures Mr. James Paul

Enclosed material is retained in subcommittee files.

Statement on Shippingport Decontamination Activities
for
The Subcommittee on Investigations and Oversight
and
The Subcommittee on Eneregy Research and Production of
The Committee on Science and Technology

by
Mr. Floyd L. Culler, President
Electric Power Research Institute

I am pleased to submit this brief written statement for inclusion in the record on the Department of Energy's program to decommission the power reactor at Shippingport, Pennsylvania. Nuclear power plant decommissioning is one of the areas of the commercial nuclear business where the outstanding technical issues are minor and are only related to minimizing costs. Therefore decommissioning is not now and need not become a significant issue. In accordance with the research priorities of U.S. utilities, EPRI's involvement to date in this issue has been limited. Our current involvements are restricted to a few selected technical areas that are related to decommissioning. A greater level of effort is being spent on extending the operating life of LWRs, thereby postponing the need for decommissioning.

The Department of Energy's project to decommission Shippingport provides an opportunity to demonstrate some of the tools, techniques and management associated with the dismantlement of a power reactor similar in design to other light water reactors in operation in the United States today. The Shippingport activities provide a relative benchmark of the effectiveness of available decommissioning procedures in a radiation environment and on a full-size reactor. This experience can be used to identify areas where procedures need to be modified or improved.

Dismantlement consists of removing components and materials in an orderly, safe, and cost-effective manner. The technologies employed include the cutting of metal, pipes, support structures and other such materials, at times remotely; the blasting or cutting of contaminated concrete structures which in some cases have been previously scabbled; and in some instances, the use of selective chemical and mechanical methods for decontamination of metal components. The remote cutting and removal of a reactor pressure vessel is an important aspect that has not been demonstrated in the field as yet. Unfortunately, the plan at Shippingport is to remove the reactor pressure vessel intact, and, therefore, will not contribute knowledge in this area.

Radioactive waste handling and disposal practices are an important element of any decommissioning. There are certain features of the decommissioning at Shippingport which make waste processing and disposal practices different from those likely to be experienced by commercial U.S. utilities. For example, the disposal of the Shippingport wastes will not be regulated according to the rules established by the Nuclear Regulatory Commission. Also reported cost for the disposal of Class A wastes from Shippingport are approximately a factor of 10 lower than those being currently experienced by the commercial nuclear power industry. This consequently diminishes the motivation to reduce the amount of low level waste from the Shippingport decommissioning.

EPRI is conducting a research project to identify which particular results from Shippingport may be directly applicable to the commercial nuclear power industry and to identify those practices which do not have direct application. We applaud the efforts of the DOE and the Shippingport contractors in their efforts to apply current decommissioning techniques that may also be applicable to U.S. commercial reactors. We also recognize the very specific objectives of the Shippingport decommissioning project. EPRI will continue to endeavor to assist our member utilities through decommissioning evaluations and such other efforts which are commensurate with their needs and our resources.

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RAS:962

# Statement on Shippingport Decontamination Activities
for
The Subcommittee on Investigations and Oversight
and
The Subcommittee on Eneregy Research and Production of
The Committee on Science and Technology

by
Mr. Floyd L. Culler, President
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* * * * * * * *

RAS:962

BALTIMORE
GAS AND
ELECTRIC

CHARLES CENTER • P. O. BOX 1475 • BALTIMORE, MARYLAND 21203

W. JAMES LIPPOLD
MANAGER
NUCLEAR ENGINEERING SERVICES DEPARTMENT

July 30, 1986

Mr. James Paul
House of Representatives
300 New Jersey Avenue, SE
Room 822
Annex #1
Washington, D.C. 20515

Dear Mr. Paul:

Several weeks ago, you asked for more information concerning the basis for our determination of decommissioning costs for Calvert Cliffs Nuclear Power Plant. I have attached a document which is the basis for that determination. In addition, I am attaching a short explanation of how we collect the funds for the eventual decommissioning of Calvert Cliffs.

If I can be of any further assistance, please call me.

Jim Lippold

WJL/jwb

Attachments

cc: Messrs. J. A. Tiernan (w/o attach)
E. J. Neumann

ATTACHMENT 1

Company Exhibit RFA-1

COST OF DECOMMISSIONING
CALVERT CLIFFS UNITS NOS. 1 AND 2

R. F. Ash
January 29, 1981

INTRODUCTION

The purpose of this study is to determine reasonable cost estimates for the decommissioning of both 2700 MW (th) Calvert Cliffs units. This study reviews decommissioning of both PWR units using the present day technologies of Immediate Dismantlement, Entombment and Passive Safe Storage (Mothballing). More detail will be provided on these methods later in the report. Also, all costs in this report are given in 1980 dollars.

Major guidance for this report was obtained from NUREG/CR-0130 (References 1, 2, and 4) and several industry-generated documents (References 5, 6, and 7). In general, the NUREG methodology was used for this study, and the industry studies were consulted for areas not adequately addressed by the NUREG. The NUREG provides an extensive analysis of the decommissioning cost for the TROJAN Nuclear Plant (References 1, 2, and 4) and thus provides a basis for the performing decommissioning cost estimates for similar PWR plants including Calvert Cliffs.

SUMMARY AND CONCLUSION

Immediate dismantlement is the preferred decommissioning method. This method provides the most cost effective and environmentally sound approach of the three decommissioning alternatives. The results of this study show that the cost for immediate dismantlement is $81 million and will require about six years to accomplish. This time frame is consistent with NUREG/CR-0130 and is considered by the NRC to be the same for all large PWR plants.

Preparations for Passive Safe Storage (Mothballing) is estimated to take about three years to complete (Reference 1, 2, and 4). The initial cost for this mode of decommissioning is estimated to be $20 million. However, there will be a continuing cost for maintenance and surveillance during this safe storage period (estimated to be $100,000 annually). Adding estimates for local property taxes for 50 years and for final dismantlement after 50 years, the total cost for this option amounts to $89 million.

The initial cost for entombment with reactor vessel internals intact is estimated to be $54 million. There is an additional cost as in the case of safe storage for the necessary ongoing surveillance and maintenance of the site. This cost is estimated to be $50,000 per year and is assumed to be the same for any size nuclear plant (Reference 4). Adding local taxes and final dismantlement costs gives a total cost of $92 million.

At the present time, there is some indication that NRC will not allow dismantlement to be delayed indefinitely (reference 3). It is expected that NRC will define an acceptable deferral period sometime in the near future based on the expected life of the entombment or mothballed structures. Without this guidance, an arbitrary deferral period of 50 years was selected.

DECOMMISSIONING ALTERNATIVES FOR CALVERT CLIFFS

Several options are currently available when considering the decommissioning of Calvert Cliffs or any other nuclear reactor facility. These options are listed and described below:

(1) Immediate Dismantlement:

This method involves the total dismantlement and removal of the vestiges of the plant with the possible exception of the non-contaminated subgrade foundations. All activated and contaminated materials would be removed from the site. Upon completion of the dismantling operation, the plant would be restored to approximately the same condition that existed prior to the installation of the reactor facility making it available for unrestricted use. The advantages of immediate dismantlement are as follows:

(a) Elimination of long-term security, maintenance, and environmental surveillance.

(b) No annual local property taxes on a non-productive facility.

(c) No adverse visual impact to the local area.

(d) Presents lowest overall cost.

(e) License termination in near term.

(f) Unrestricted use of site will be available following reactor shutdown.

Disadvantages of Immediate Dismantlement are:

(a) Higher radiation exposures of workers.

(b) Larger shipments of radioactive waste.

(c) Higher initial cost.

(2) Passive Safe Storage (Mothballing):

This alternative renders the facility virtually unchanged except that all the fuel assemblies, radioactive waste and fluids would be removed from the site. However, a significant radioactive inventory in such items as core internals, pressure vessel, and portions of the biological shield will be left on site. The advantages of this alternative are:

(a) Lowest initial cost.

(b) Lower radiation exposure rates.

The disadvantages are:

(a) Continued radiation monitoring.

(b) Environmental surveillance (long term).

(c) Round-the-clock security.

(d) Periodic maintenance of structures.

(e) Future site use severly restricted.

(3) Partial Dismantlement (Entombment)

This method consists of removal of all plant structures except the containment structure and the sealing of all the highly radioactive or contaminated components with a concrete structure integral with the biological shield. Advantages of this decommissioning method are:

(a) Lower initial expenditure of funds.

(b) Potential for least overall cost (but only if no further decommissioning required).

(c) Lower radiation exposures.

(d) On-site security requirements limited.

The disadvantages are:

(a) Responsibility for confinement of the residual radioactivity remains with the licensee until the site can be released from unrestricted use.

(b) Potential for higher cost than immediate dismantlement.

(c) Maintenance of a possession-only license.

METHODOLOGY AND ASSUMPTIONS

The following discussion of methodology and cost is based principally on Technology and Cost of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, June 1978 (Reference 1) and NUREG/0130 Addendum, August 1979 (Reference 2). The reference pressurized reactor (PWR) in the NUREG/CR-0130 study is the Trojan Nuclear Plant. Both Calvert Cliffs Units 1 and 2 do not utilize cooling towers, whereas Trojan does and Calvert Cliffs employs two loops for cooling with two steam generators whereas Trojan employs 4-loops for cooling with four steam generators. Also, both Calvert Cliffs units are designed for a thermal power rating of 2700 MW whereas Trojan is designed for 3500 MW (th).

Knowing the thermal power ratings of both plants and comparing the dimensions and characteristics of both Calvert Cliffs units with corresponding features of the Trojan Power Plant, cost estimates in this study were derived. As a result of the comparison a ratio or scaling factor was determined (Reference 4). Thus, the estimated dismantlement cost for each item in tables (I - V) was determined by multiplying the estimated cost of dismantling the similar item in the Trojan Power Plant by this overall scaling factor. Because we have two nuclear plants this scaling factor was multiplied by 2. Since the NRC study was based on 1978 dollars, an escalation factor of 1.26 was applied to bring the costs to 1980 dollars. This number was provided by the Finance Department (Reference 8). To get the total cost, all the items were summed up and multiplied by a 25% contingency factor (References 1, 4; Tables I-V).

The costs for disposal of spent fuel were not included in this study since those expenses form part of fuel costs for accounting purposes.

DEFINITIONS OF ITEMS USED IN TABLES I-V

Activated Materials Disposal - The cost related to removal and disposal of the reactor vessel, internals, and biological shield.

Containment Internals - The steam generators pressurizer, associated tanks, heat exchangers, materials within the reactor containment.

Other Building Materials - The tanks, piping, heat exchangers, pool liners, and all other contaminated materials within the fuel, Auxiliary and Control buildings.

Waste Disposal - Disposal of liquid waste, ion exchanger, filter cartridges, and miscellaneous dry wastes.

Staff Labor - All staff labor except the labor cost of the Demolition Contractor and the Speciality Contractor.

Facility Demolition - The costs associated with demolition of the non-contaminated and dismantled structures, including special equipment, explosive specialist, rubble removal and backfitting to grade levels.

Miscellaneous Supplies - Items such as disposable protective clothing, decontamination chemicals, assorted cleaning agents, rags, maps, plastic bags and sheeting, glass-fiber and HEPA filters, ion exchange resins and fluid filter cartridges, expendable tools, etc.

Speciality Contractors - Special services such as a mobile radwaste treatment system, explosives specialist working on dismantling and decontamination, and the final landscaping of the site.

Nuclear Insurance Cost - Total cost for Nuclear liability Insurance.

Special Equipment - Anticipated tools to be used.

Electrical Costs	- The power costs associated with providing essential systems and services that must remain in place until all radioactive and/or contaminated material have been removed from the site (e.g. operating and cold shutdown plant load).
Environmental Surveillance	- Measuring any releases of radioactivity to the environment.

TABLE I

DECOMMISSIONING COSTS FOR IMMEDIATE DISMANTLEMENT OF CALVERT CLIFFS UNITS 1 & 2

(Dollars in Millions)

Category	Cost (1980 Dollars)
Activated Material Disposal	5.7
Contaminated Containment Material Disposal	2.0
Other Building's Contaminated Material Disposal	8.7
Radioactive Waste Disposal	1.4
Dismantlement Staff Labor	18.7
Electrical Power	7.3
Special Equipment	1.7
Miscellaneous Supplies	3.2
Facility Demolition	13.3
Speciality Contractors	0.8
Nuclear Insurance	1.7
Environmental Surveillance	0.3
Local Property Taxes	0.2
Subtotal	65.0
Contingency (25%)	16.3
TOTAL:	81.3

TABLE II

DECOMMISSIONING COSTS FOR PASSIVE SAFE STORAGE (MOTHBALLING) AND DELAYED DISMANTLEMENT OF CALVERT CLIFFS UNITS 1 & 2

(Dollars in Millions)

Category	Cost (1980 Dollars)
Staff Labor	7.6
Speciality Contractors	0.5
Radioactive Waste Disposal	1.1
Nuclear Insurance	0.6
Miscellaneous Supplies	1.8
Special Tools and Equipment	0.2
Electrical Power	3.9
Security System Additions	0.2
Subtotal	15.9
Contingency (25%)	4.0
Total	19.9
Annual Surveillance Costs for 50 years	5.0
Local property taxes for 50 years	1.5
Final dismantlement cost after 50 years (Table III)	62.9
TOTAL	89.3

TABLE III

DISMANTLEMENT COSTS* DEFERRED FOR 50 YEARS FOLLOWING PASSIVE SAFE STORAGE

(Dollars in Millions)

Category	Cost (1980 Dollars)
Equipment	2.0
Supplies	2.2
Power	8.5
Activated Materials	7.1
Contaminated Materials	0.1
Radioactive Waste Disposal	0.7
Staff Labor	23.3
Contractor Services	1.4
Nuclear Insurance	1.0
Facility Demolition	16.6
TOTAL	62.9

*Includes 25% Contingency

TABLE IV

DECOMMISSIONING COSTS FOR PARTIAL DISMANTLEMENT (ENTOMBMENT) AND DELAYED TOTAL DISMANTLEMENT OF CALVERT CLIFFS UNITS 1 AND 2
(Dollars in Millions)

Category	Cost (1980 Dollars)
Other Building's Contaminated Material Disposal	1.0
Radioactive Waste Disposal	1.4
Staff Labor (Dismantlement)	14.3
Staff Labor (Entombment)	2.5
Electrical Power	7.3
Special Equipment	1.7
Miscellaneous Supplies	3.2
Nuclear Insurance	1.7
Speciality Contractors	0.6
Environmental Surveillance	0.3
Security System Additions	0.2
Entombment Barrier Installation	0.6
Demolition	8.5
Subtotal	43.3
Contingency	10.8
TOTAL	54.1
Annual Surveillance Costs (50 years)	2.5
Local Taxes (50 years)	1.5
Final Dismantlement Cost (Table V)	34.2
TOTAL	92.3

TABLE V

DISMANTLEMENT COSTS* DEFERRED FOR 50 YEARS FOLLOWING PARTIAL DISMANTLEMENT
(Dollars in Millions)

Category	Cost (1980 Dollars)
Equipment	2.0
Supplies	2.2
Power	4.0
Labor	11.7
Facility Demolition	6.0
Nuclear Insurance	1.0
Radioactive Waste Disposal	0.1
Activated Materials	7.1
Contaminated Materials	0.1
TOTAL	34.2

*Includes 25% Contingency

REFERENCES

(1) Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station Vol. 1 (NUREG/CR-0130).

(2) Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station Vol. 11 (NUREG/CR-0130).

(3) Letter from Lee Gossick, Executive Director of Operations, U. S. Nuclear Regulatory Commission to Monte Canfield, Director of Energy and Minerals Division of the U. S. General Accounting Office dated June 10, 1977.

(4) Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station (NUREG/CR-0130 Addendum).

(5) Decommissioning Study for the Connecticut Yankee Nuclear Power Plant; Northeast Utilities Service Company.

(6) Estimated Cost for Decommissioning of Three Mile Island Nuclear Generating Station Unit No. 1; Exhibit No. E-3, Page 1 of 4.

(7) Letter from Mr. C. K. Feist of Texas Utilities Services, Inc. File No. 619.12, dated October 30, 1980, to Mr. Roger E. Martin of Dusquene Light re: Estimated Decommissioning Cost of Conanche Peak Steam Electric Station.

ATTACHMENT 2

Decommissioning

Baltimore Gas and Electric Company is currently utilizing the internal reserve method in collecting the estimated costs of decommissioning its Calvert Cliffs Nuclear Power Plant. Under this approach, the amounts collected from customers are recorded in a separate account on the Company's books and the cash is used to finance other utility construction projects. By using the cash collected for nuclear decommissioning for other utility purposes in the interim, the Company avoids the higher costs of acquiring necessary external funds through the financial markets. The result is that the overall cost for electricity is lower during the period prior to actual decommissioning of the plant than what it would have been if the cash collected for decommissioning had been segregated in a fund external to the Company. Under the internal reserve approach, the cash required at the time of actual decommissioning will come from two sources. The first will be through external financings by the Company at an amount equivalent to customers' previous payments. The other will be from the Federal Government in the form of tax savings by being able to deduct actual decommissioning expenses.

The specifics of Baltimore Gas and Electric's internal reserve approach are as follows. The approach was implemented effective June 1, 1984 after review and approval by the Maryland Public Service Commission. It was based on the estimated cost of dismantling the Calvert Cliffs Nuclear Plant at the end of its service life. This cost was estimated via an engineering study to be $81 million at 1980 price levels. Assuming a five percent inflation factor prevails between now and the year 2009, the cost of decommissioning in the year 2009 would be $333.4 million. This translates into $180 million after reflecting the associated tax deduction. The annual amount collected from customers for decommissioning is based on an annuity design to produce the $180 million by the year 2009 through payments by customers and imputed interest on those payments. The annuity calculation results in customers making equivalent payments on a present value basis for each year of Calvert Cliffs' operation through 2009. The rate used for imputing interest is the Company's earned rate of return from the previous year, which in 1985 was 10.21% after taxes. The annuity calculation is performed each year to incorporate the Company's most recent earned return.

From a reporting standpoint, the Company files annually with the Maryland Public Service Commission a report detailing the beginning internal reserve balance, payments by customers during the year, imputed interest, and the ending internal reserve balance. Therefore, the Commission is able to closely monitor the Company's process of providing for the cost of decommissioning Calvert Cliffs.

○